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AN ABRIDGMENT

OF THE

HYGIENIC PHYSIOLOGY,

WITH SPECIAL REFERENCE TO

ALCOHOLIC DRINKS AND NARCOTICS.

FOR THE USE OF JUNIOR CLASSES AND COMMON SCHOOLS.

BY

JOEL DORMAN STEELE, PH.D.

A. S. BARNES & COMPANY,

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SUGGESTIONS TO TEACHERS.

SEEING is believing,—more than that, it is often knowing and remembering. The mere reading of a statement is of little value compared with the observation of a fact. Every opportunity should therefore be taken of exhibiting to the pupil the phenomena described, and thus making them real. It is hoped that the simple Experiments scattered through the text will be performed. The skilful teacher will be able to draw from them much valuable instruction. A microscope is indispensable to the proper understanding of Physiology. A suitable instrument and carefully prepared specimens showing the structure of the bones, the skin, and the blood of various animals, the pigment cells of the eye, etc., may be obtained at a small cost from the Publishers of this book.

On naming the subject of a paragraph, the pupil should be prepared to tell all he knows about it. No failure should discourage the teacher in establishing this mode of study and recitation. A little practice will produce the most satisfactory results. The unexpected question and the apt reply develop a certain

sharpness and readiness which are worthy of cultivation. The Practical Questions, the Questions for Review, or any other that the wit of the teacher may suggest, can be effectively used to break the monotony of a topical recitation, thereby securing the benefits of both systems. Many additional Practical Questions, and interesting Notes will be found in the Hygienic Physiology.

The pupil should expect to be questioned each day upon any subject passed over during the term, and thus the entire knowledge gained will be within his grasp for instant use. While some are reciting to the teacher, let others write on slates or on the blackboard. At the close of the recitation let all criticise the ideas, the spelling, the use of capitals, the pronunciation, the grammar, and the mode of expression. Greater accuracy and much collateral drill may thus be secured at little expense of valuable school-time.

The Introduction is designed merely to furnish suggestive material for the first lesson, preparatory to beginning the study. Other topics may be found in the questions given in the Appendix.

To the description of each organ is appended an account of its most common diseases, accidents, etc., and, when practicable, their mode of treatment. A pupil may thus learn, for example, the cause and cure of a cold, the management of a wound, or the nature of an inflammation.

In the Appendix will be found Questions for Review, Hints about the sick-room, Suggestions as to "what to do till the doctor comes," Antidotes for poisons, a Glossary, and an Index.

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INTRODUCTION.

PHYSIOLOGICAL STUDY in youth is of inestimable value. Precious lives are frequently lost through ignorance. Thousands squander in early years the strength which should have been kept for the work of real life. Habits are often formed in youth which entail weakness and poverty upon manhood, and are a cause of life-long regret. The use of a strained limb may permanently damage it. Some silly feat of strength may produce an irreparable injury. A thoughtless hour of reading by twilight may impair the sight for life. A terrible accident may happen, and a dear friend perish before our eyes, while we stand by powerless to render the assistance we could so easily give did we "only know what to do." The thousand little hints which may save or lengthen life, may repel or abate disease, and the simple laws which regulate our bodily vigor, should be so familiar that we may be quick to apply them in an emergency. The preservation of health is easier than the cure of disease. Childhood cannot afford to wait for the lesson of experience which is learned only when the penalty of violated law has been already incurred, and health irrevocably lost.

Nature's Laws Inviolable.—In infancy, we learn how terribly Nature punishes a violation of certain laws, and how promptly she applies the penalty. We soon find out the peril of fire, falls, edged-tools, and the like. We fail, however, to notice the equally sharp and certain

punishments which bad habits entail. We are quick to feel the need of food, but not so ready to perceive the danger of an excess. A lack of air drives us at once to secure a supply; but foul air is as fatal, yet gives us no warning.

Nature provides a little training for us at the outset of life, but leaves the most for us to learn by bitter experience. So in youth we throw away our strength as if it were a burden of which we desired to be rid. We eat anything, and at any time; do anything we please, and sit up any number of nights with little or no sleep. Because we feel only a momentary discomfort from these physical sins, we fondly imagine when that is gone we are all right again. Our drafts upon our constitution are promptly paid, and we expect this will always be the case; but some day they will come back to us protested; Nature will refuse to meet our demands, and we shall find ourselves physical bankrupts.

We are furnished in the beginning with a certain vital force upon which we may draw. We can be spendthrifts and waste it in youth, or be wise and so husband it to manhood. Our shortcomings are all charged against this stock. Nature's memory never fails: she keeps her account with perfect exactness. Every physical sin subtracts from the sum and strength of our years. We may cure a disease, but it never leaves us as it found us. We may heal a wound, but the scar still shows. We reap as we sow, and we may either gather in the thorns, one by one, to torment and destroy, or rejoice in the happy harvest of a hale old age.

THE SKELETON.

THE **Skeleton**, or framework of the "House we live in," is composed of about 200 bones. The number varies in different periods of life, several which are separated in youth becoming united in old age.

The Uses of the Bones are chiefly : *First*, to protect the delicate organs within us ; *Second*, to aid the muscles in producing motion ; and *Third*, to keep the body in shape.

The Forms of the Bones are adapted to their various uses.

Experiment.—Cut a sheet of foolscap into two pieces. Make of one a firm, hollow roll, and of the other a close, flat strip. Support the ends of each, and hang weights in the middle. The roll will bear a much heavier weight than the strip.

Now, in our limbs, we need size, strength, and lightness, in order to carry burdens, to bear the body in walking, and to furnish a support for the muscles ; hence, we here find long, round, hollow bones. Over cavities we have flat bones, and where we require strength in a small space we have short, thick ones.

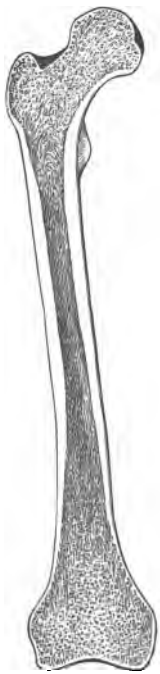
The Bones are Composed of animal and mineral matter, the proportion varying with the age.

Experiments.—1. Take two bones. Soak one in weak muriatic acid, and burn the other in the fire. The shape of both will remain unchanged,

but the one becomes a tough, gristly substance (cartilage), while the other can be crumbled into powder. The acid has destroyed the mineral, the fire has consumed the animal, matter. 2. Mix a wineglass of muriatic acid with a pint of water, and place in it a sheep's rib. In a day or two, the bone will be so soft that it can be tied into a knot. 3. In the same way, an egg may be made so pliable that it can be crowded into a narrow-necked bottle, within which it will expand, and become an object of great curiosity to the uninitiated. 4. Compare the breast-bone of a young and an old fowl.

We thus see that a bone receives hardness and rigidity from its mineral, and tenacity and elasticity from its animal, matter.

Fig. 2.



The thigh-bone, or femur, sawed lengthwise.

All bones are at first either simple tissue or cartilage, which gradually *ossifies* (turns to bone). Certain portions near the joints ossify very slowly, and so, meantime, keep tough and elastic. Hence the bones of children are not readily fractured, and when broken easily heal again; while those of elderly people are liable to fracture, and do not quickly unite.

The Structure of the Bones may be easily illustrated.

Experiments.—1. Saw a bone lengthwise. You will find it filled with a spongy substance. At the ends, where size is required to make a strong joint, this filling is abundant and porous; while, near the middle, where strength alone is needed, the bone itself is thicker. Each fiber of this filling eases the shock of a sudden blow. 2. Examine a freshly-cut bone. It is not the dry, lifeless thing you may have supposed, but a moist, pinkish structure, covered with a tough membrane, and containing a rich fat marrow, full of blood-vessels.

3. Put a thin slice under the microscope. You will see black spots, with lines running in all directions, and looking very like minute insects. The spots are little cavities, and the lines are tiny tubes.

Growth of the Bones.—The blood circulates freely through the bones, and the whole bone-structure is constantly but slowly changing, old material being taken out and new put in. A curious illustration is seen in the fact that if madder be mixed with the food of pigs, it will tinge their bones red.

Repair of the Bones.—If you break a bone, the blood at once oozes out of the fractured ends. Afterward comes a watery fluid, which in a fortnight thickens to a gristly substance strong enough to hold them together. Bone-matter is then slowly deposited, which in five or six weeks will unite the broken parts.

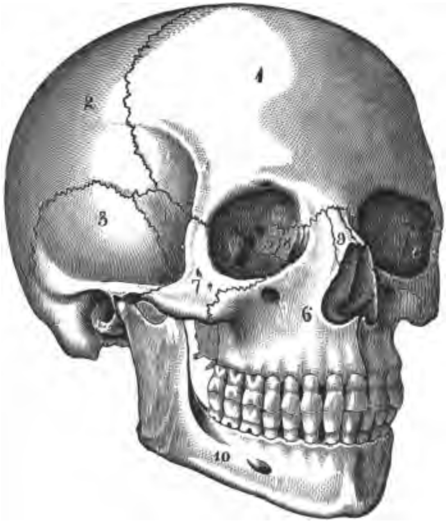
A broken limb should always be held in place by splints; a sudden jar might rupture the partially-mended break. As, for a long time, the new portion consists largely of animal matter, and so is tender and pliable, great care is necessary to prevent a misshape of the bone.

The Joints are packed with a soft, smooth cartilage, or gristle. In addition, the ends of the bones are covered with a thin membrane that secretes a fluid, not unlike the white of an egg, which prevents the noise and wear of friction. The body is the only machine that oils itself.

general

The bones which form the joint are tied with stout ligaments, or bands, of a smooth, silvery-white tissue, so strong that the bones are sometimes broken without injuring the fastenings.

Fig. 3.



The Skull.—1, frontal bone; 2, parietal bone; 3, temporal bone; 4, the sphenoid bone; 5, ethmoid bone; 6, superior maxillary (upper jaw) bone; 7, malar bone; 8, lachrymal bone; 9, nasal bone; 10, inferior maxillary (lower jaw) bone.

Classification of the Bones.—For convenience, the bones of the skeleton are considered in three divisions: the *head*, the *trunk*, and the *limbs*.

1. **The Head.**—THE BONES OF THE SKULL AND FACE form a cavity for the brain. None moves except the lower jaw, which is hinged at the back.

Experiment.—Try in how many different directions you can move your jaw, and find what muscles you use.

THE SKULL-BONES are composed of two compact plates, with a spongy layer between. These are in several pieces, the outer ones being joined by notched edges (sutures, sūt'yurs) in a way carpenters term dove-tailing.

The skull is, in fact, a strong bone-box which shelters the brain—an organ so delicate that, if unprotected, an ordinary blow would destroy it. Its egg shape adapts it to resist pressure. The smaller and stronger end is in front, where the danger is greatest. Projections before and behind shield the less protected parts. The hard plates resist, and the spongy packing deadens, every blow. The dove-tailed joinings disperse jars and prevent fractures from spreading, while the frequent openings afford safe passage for nerves and blood-vessels to the other parts of the body.

Fig. 4.

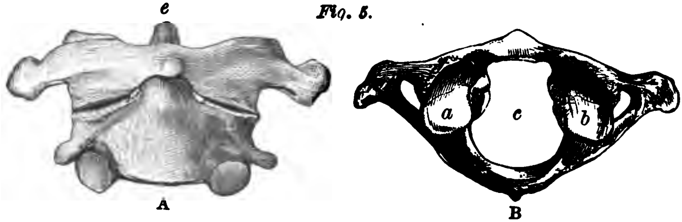
The Spine.

2. **The Trunk.**—THE TRUNK has two important cavities. The upper part, or *chest*, contains the heart and the lungs, and the lower part, or *abdomen*, holds the stomach, liver, kidneys, and other organs (Fig. 27). The principal bones are those of the *spine*, the *ribs*, and the *hips*.

THE SPINE consists of twenty-four bones (*vertebræ*), between which are placed pads of cartilage. Within the column is a canal for the spinal cord. Strong projections at the back and on either side are abundant for the attachment of the muscles. The packing acts as a cushion to prevent the jar from reaching the brain when we jump or run while the double curve disperses the force of a fall.

THE PERFECTION OF THE SPINE surpasses all human contrivances. A chain of twenty-four bones is at once so stiff that it will bear a heavy burden, and so flexible that it will bend like rubber. Resting upon it, the brain is borne without a tremor; clinging to it, the vital organs are carried without fear of harm; and, snugly hidden within it, lies a delicate nerve that would thrill with the slightest touch.

Fig. 5.



B, *the first cervical vertebra, the atlas;* A, *the atlas, and the second cervical vertebra the axis;* e, *the odontoid process;* c, *the foramen.*

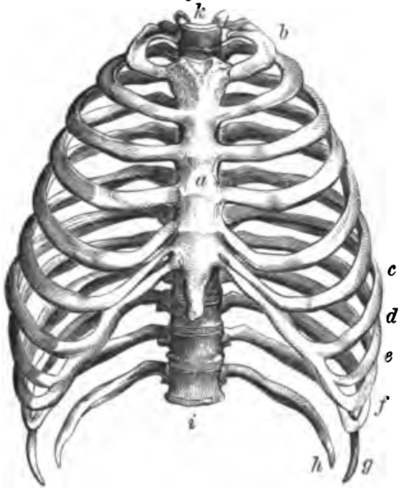
THE JOINT BETWEEN THE SKULL AND THE SPINE IS A VERY PECULIAR ONE.—On the top of the upper vertebra (*atlas*) are two little hollows (*a, b,* Fig. 5), into which fit the corresponding projections on the lower part of the skull, and thus the head can rock to and fro. The second vertebra (*axis*) has a peg, *e*, which projects through a hole, *c*, in the first. Thus, when we move the head sidewise, the atlas turns round the peg of the axis.

THE RIBS, also twenty-four in number, are arranged in pairs on each side of the chest. At the back, they are all attached to the spine. In front, the upper seven pairs are tied by cartilages to the breast-bone; three are fastened to each other and

the cartilage above, and two, the floating ribs, are loose.

If the chest-wall were a single, thick bone, it would be heavy, and unwieldy. As it is, the long,

Fig. 5.



The Thorax, or Chest: a, *the sternum, or breast-bone;* b *to* c, *the true ribs:* d *to* h, *the false ribs;* g, h, *the floating ribs;* i k, *the dorsal vertebræ.*

slender ribs, the arched form, and the connecting cartilages furnish lightness, strength, and elasticity, —just what we need to breathe easily, and, at the same time, to protect the delicate organs within. The natural chest is smaller at the top than at the bottom, but our tight clothing often reverses this shape.

THE HIP-BONES form a kind of basin (*pelvis*). In the upper part, is the foot of the spinal column—a wedge-shaped bone firmly planted between the solid

bones of the hip, like the keystone to an arch,—a steady support to the heavy burden above.

Fig. 7.

The Pelvis (a basin); a, *the sacrum (sacred)*; b, b, *the right and left innominata, cr nameless bones.*

3. **The Limbs.**—TWO SETS OF LIMBS branch from the trunk, viz.: the upper, and the lower. They closely resemble each other. The arm corresponds to the thigh; the fore-arm, to the leg; the wrist, to the ankle; the fingers, to the toes.

Fig. 8.

The Shoulder-joint: a, *the clavicle;* b, *the scapula.*

1. THE UPPER LIMBS.—*The Shoulder.*—The bones of the shoulder are the collar-bone (clavicle), and the shoulder-blade (scapula).

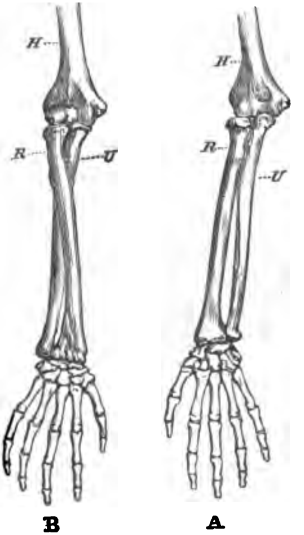
The *clavicle* is a long, slender bone, shaped like the Italic *f*. It is fastened at one end to

the breast-bone and the first rib, and, at the other, to the shoulder-blade. It thus holds the shoulder-joint out from the chest, and gives the arm greater play.

The Shoulder-blade is a thin, flat, triangular bone, fitted to the top and back of the chest, making a foundation for the muscles of the shoulder.

The Shoulder-joint.—The arm-bone, or *humerus*, is attached to the shoulder-blade by a ball-and-socket joint. This consists of a cup-like cavity in the latter bone, and a rounded head in the former to fit it,—thus allowing a free rotary motion. The shallow socket causes a frequent dislocation of this joint, but a deep one would spoil the easy swing of the arm.

Fig. 9.



Bones of right Fore-arm; H, the humerus; R, the radius; U, the ulna.

The Elbow.—At the elbow, the humerus is attached to the *ulna*—a slender bone on the inner side of the fore-arm—by a hinge-joint which admits of motion only backward and forward. The head of the *radius*, or large bone of the fore-arm, is convex at the elbow, and fits into a shallow cavity in the ulna, while at the wrist the ulna plays in a similar socket in the radius. Thus the radius may roll over the ulna.

The Wrist consists of two

rows of irregular bones, one of which is attached to the fore-arm; the other, to the hand. They are placed side to side and so firmly fastened as to admit of only a gliding motion. This gives little play, but great strength, elasticity, and power of resisting shocks.

The Hand.—The bones of the palm support each a thumb or finger. Each finger has three bones, but the thumb has only two. The first bone of the thumb, standing apart from the rest, enjoys a special freedom of motion, and adds greatly to the usefulness of the hand.

Fig. 10.

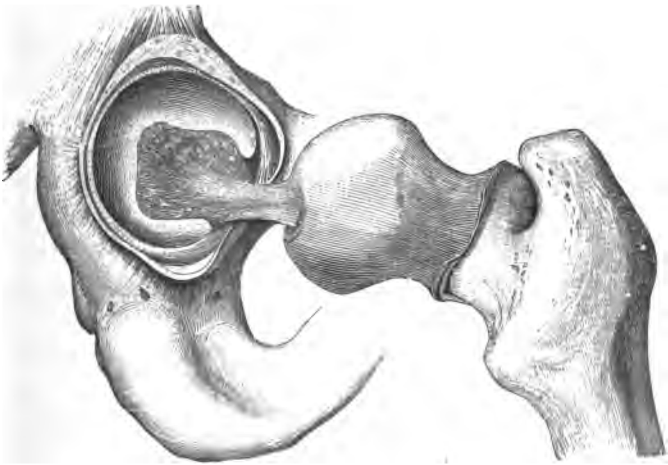
Bones of the Hand and the Wrist.

The first bone of each finger is so attached to the corresponding bone of the palm as to move in several directions upon it, but the others have simple hinge-joints.

The fingers are named in order: the thumb, the index, the middle, the ring, and the little finger. Their different lengths cause them to fit the hollow of the hand when it is closed, and probably enable us more easily to grasp objects of varying size.

Experiment.—If you clasp a ball with your hand, the tips of your fingers will form a straight line.

Fig. 11.



The Hip-joint.

2. The Lower Limbs.—*The Hip.*—The thigh-bone, or *femur*, which, at every step, has to bear our weight, is the largest and strongest in the skeleton. It is attached to the hip-bone by a ball-and-socket joint. Unlike the shoulder-joint, the cup here is deep, thus affording less play, but greater strength.

The Knee is strengthened by the knee-pan (*patella*, little dish), a chestnut-shaped bone firmly fastened over the joint.

The shin-bone (*tibia*), the large, triangular bone on the inner side of the leg, is attached to both the femur and the foot by a hinge-joint. The knee-joint admits of a slight rotary motion when the limb is not extended.

The *fibula* (*fibula*, a clasp), the small, outside bone of the leg, is strongly bound at both ends to the tibia

(Fig. 1). It is immovable, and, as the tibia bears the principal weight of the body, the chief use of this second bone seems to be to give more surface to which the muscles may be attached.

The Foot.—The graceful arch of the foot, and the numerous bones joined by cartilages (Fig. 1), give an elasticity to the step that could never be attained by a single, flat bone. The toes naturally lie straight forward in the line of the foot. Few persons in civilized nations, however, have naturally-formed feet. The big toe is crowded upon the others, while crossed toes, in-growing nails, corns, and bunions abound.

The cause of these deformities is found in the shape and size of fashionable boots and shoes. Narrow points pinch our toes, and compel them to override one another; narrow soles compress the arch; while high heels, by throwing all the weight forward on the toes, strain and enlarge the ankle.

When we are measured for boots or shoes, we should *stand* on a sheet of paper, and have the shoemaker mark with a pencil the exact outline of our feet as they bear our whole weight. When the shoe is made, the sole should exactly cover this outline, while the heels should be low, flat, and broad.

Diseases.—1. The Rickets are caused by a lack of mineral matter in the bones, rendering them soft and pliable, so that they bend under the weight of the body. The disease is cured by a more nutritious diet, or by taking phosphate of lime to supply the lack.

2. Bowlegs are produced by children standing on their feet before the bones of the lower limbs are strong enough to bear their weight. A young child should never be urged to stand. Nature will set him on his feet when the proper time comes.

3. Curvature of the Spine.—When the spine is bent, the packing between the vertebræ becomes compressed on one side into a wedge-like shape. After a time, it will lose its elasticity, and the spine become distorted. This occurs in the case of students who bend forward to bring their eyes nearer their books, instead of lifting their books nearer their eyes, or who raise their right shoulder above their left when writing at a desk which is too high. Round shoulders, small, weak lungs, and, oftentimes, diseases of the spine are the consequences. An erect posture in reading or writing conduces not alone to beauty of form, but also to health of body.

4. Sprains are produced when the ligaments which bind the bones of a joint are strained, twisted, or torn from their attachments. They are quite as harmful as a broken bone, and require careful attention, lest they lead to a crippling for life. The use of a sprained limb may permanently impair its strength.

5. A Dislocation is produced by the rupture of the tissues of the joint so that the head of the bone is driven out of its socket and into some other place both by the force of the blow which caused the injury and by the contraction of the muscles.

PRACTICAL QUESTIONS.

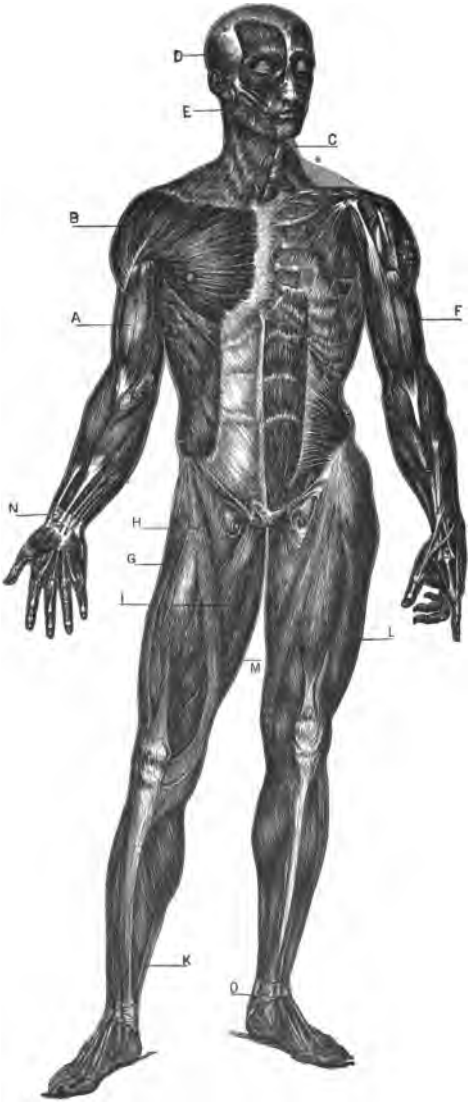
1. Why does not a fall hurt a child as much as it does a grown person?
2. Should a young child ever be urged to stand or walk?
3. What is meant by "breaking one's neck"?
4. Should chairs or benches have straight backs?
5. Should a child's feet be allowed to dangle from a high seat?
6. Why can we tell whether a fowl is young by pressing on the point of the breast-bone?
7. What is the use of the marrow in the bones?
8. Why is the shoulder so often put out of joint?
9. How can you tie a knot in a bone?
10. Why are high pillows injurious?
11. Why should we not wear narrow-toed shoes?
12. Should a boot have a heel-piece?

13. Why should one always sit and walk erect?
14. Why does a young child creep rather than walk?
15. What is the natural direction of the big toe?

ANALYSIS OF THE SKELETON.

THE SKELETON.

- **I. THE HEAD.** *(28 bones.)*
  - 1. Cranium (*8 bones*).
    - Frontal Bone (forehead).
    - Two Parietal bones.
    - Two Temporal (temple) bones.
    - Sphenoid bone.
    - Ethmoid (sieve-like bone at root of nose).
    - Occipital bone (back and base of skull).
  - 2. Face (*14 bones*).
    - Two Superior Maxillary (upper jaw) bones.
    - Inferior Maxillary (lower jaw) bone.
    - Two Malar (cheek) bones.
    - Two Lachrymal bones.
    - Two Turbinated (scroll-like) bones, each side of nose.
    - Two Nasal bones (bridge of nose).
    - Vomer (the bone between the nostrils).
    - Two Palate bones.
  - 3. Ears (*6 bones*).
    - Hammer.
    - Anvil.
    - Stirrup.
- **II. THE TRUNK.** *(54 bones.)*
  - 1. Spinal Column.
    - Cervical Vertebræ (seven vertebræ of the neck).
    - Dorsal Vertebræ (twelve vertebræ of the back).
    - Lumbar Vertebræ (five vertebræ of the loins).
  - 2. Ribs.
    - True Ribs.
    - False Ribs.
  - 3. Sternum (breast-bone).
  - 4. Os Hyoides (bone at the root of tongue).
  - 5. Pelvis.
    - Two Innominata.
    - Sacrum.
    - Coccyx.
- **III. THE LIMBS.** *(124 bones.)*
  - 1. Upper Limbs (*64 bones.*)
    - *Shoulder.*
      - Clavicle.
      - Scapula.
    - *Arm.*
      - Humerus.
      - Ulna and Radius.
    - *Hand.*
      - Eight Wrist or Carpal bones.
      - Five Metacarpal bones.
      - Phalanges (14 bones).
  - 2. Lower Limbs (*60 bones.*)
    - *Leg.*
      - Femur.
      - Patella.
      - Tibia and Fibula.
    - *Foot.*
      - Seven Tarsal bones.
      - Five Metatarsal bones.
      - Phalanges (14 bones.)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THE MUSCLES.

THE **Use of the Muscles.**—The skeleton is the image of death. Its unsightly appearance instinctively repels us. We have seen, however, what uses it subserves in the body, and how the ugly-looking bones abound in nice contrivances and ingenious workmanship. In life, the framework is hidden by the flesh. This covering is a mass of muscles, which not only give form and symmetry to the body, but also produce its varied movements.

Contractility.—The peculiar property of the muscles is their power of contraction. It does not cease at death, but, in certain cold-blooded animals, is often noticed long after the head has been cut off.

Arrangement of the Muscles.—The muscles are nearly all arranged in pairs, each with its antagonist, so that, as they contract and expand alternately, the bone to which they are attached is moved to and fro.

Experiments.—Grasp your arm tightly with your hand just above the elbow-joint, and bend the fore-arm. You will feel the inside muscle (biceps) swell and become hard and prominent, while the outside muscle (triceps) will relax. Now straighten the arm, and the swelling and hardness of the inside muscle will vanish, while the outside one will become rigid. 2. Clasp the arm just below the elbow, and then open and shut the fingers. You will feel the alternate expanding and relaxing of the muscles

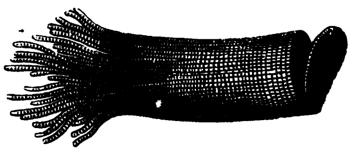
on opposite sides of the arms. 3. Place your hand on your temple, and chew. You will feel the contraction of one of the muscles that work the lower jaw.

Kinds of Muscles.—There are two kinds of muscles, the *voluntary*, which are under the control of our will, and the *involuntary*, which are not. Thus our limbs stiffen or relax as we please, but the heart beats on by day and by night. The eyelid, however, is both voluntary and involuntary, so that while we wink unconsciously, we can also control the motion.

Structure of the Muscles.—Each muscle is composed of a multitude of tiny fibers.

Experiments.—1. Wash out the red color from a piece of lean beef. You can easily detect the fine fibers of which the meat is composed. In boiling corned beef, the fibers often separate, owing to the dissolving of the delicate tissue which bound them together. 2. Place a fiber under a microscope. You will find it made up of minute filaments (*fibrils*), each fibril composed of a row of tiny cells arranged like a string of beads.

Fig. 13.



Microscopic view of a Muscle, showing, at one end, the fibrillæ; and, at the other, the disks, or cells, of the fiber.

The binding of so many threads into one bundle confers great strength. We see this illustrated in suspension bridges, where the weight is sustained by small wires twisted into massive ropes.

The Tendons.—The ends of the muscles are gen-

erally attached to the bone by strong, flexible, but inelastic tendons.

Experiment.—Compare the muscles and tendons in the roasted leg of a fowl.

The muscular fibers spring from the sides of the tendon, so that more of them can act upon the bone than if they went directly to it. Besides, the small, insensible tendon can better bear the exposure of passing over a joint, and be more easily lodged in some protecting groove, than the broad, sensitive muscle. This mode of attachment gives to the limbs strength, and elegance of form. Thus, for example, if the large muscles of the arm extended to the hand, they would make it bulky and clumsy. Even the tendons, at the wrist, become fine cords that pass to the fingers.

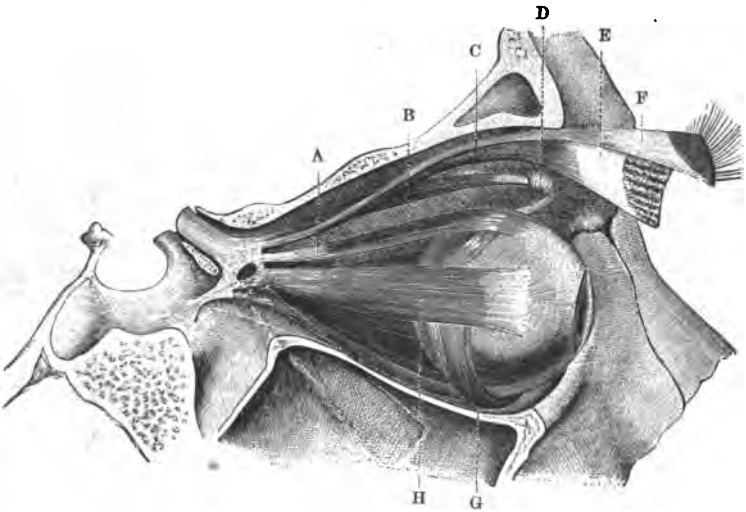
Fig. 14.

Tendons of the Hand.

Here we notice two other admirable arrangements. 1. If the long tendons at the wrist on contracting should rise, projections would be made and thus the beauty of the joint be marred. To prevent this, a stout band or bracelet of ligament holds them down to their place.

2. In order to allow the tendon which moves the last joint of the finger to pass through, the tendon which moves the second joint divides at its attachment to the bone. This is the most economical mode of packing the muscles so as not to increase the size of the slender finger.

Fig. 15.



The Muscles of the Right Eye. A, *superior straight:* B, *superior oblique passing through a pulley,* D; G, *inferior oblique;* H, *external straight, and, back of it, the internal straight muscle.*

Since the tendon cannot always pull in the direction of the desired motion, some contrivance is necessary to meet the want. The tendon (B) belonging to one of the muscles of the eye, for example, passes through a ring of cartilage (D), and thus a rotary motion is secured.

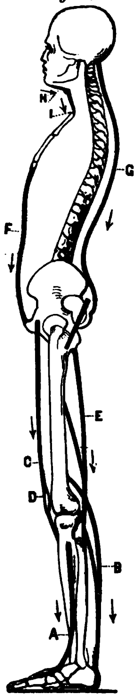
The Enlargement of the Bones at the Joints not only gives more surface for the attachment of the

Fig. 16.

The Knee-joint; h, the patella; f, the tendon.

muscles, but it enables them to work to better advantage. Thus, in Fig. 16, a muscle acting in the line *f b* would not bend the lower limb so easily as if acting in the line *f h*, since in the one case its force would be about all spent in drawing the bones more closely together, while in the other it would pull more nearly at a right angle. Thus the tendon *f*, by passing over the patella, which is itself pushed out by the protuberance *b* of the thigh-bone, pulls at a larger angle, and so the leg is thrown forward with ease in walking and with great force in kicking.

Fig. 17.



Action of the Muscles which keep the body erect.

How We Stand Erect.—It requires the action of many muscles to hold our bodies upright. The head so rests upon the spine as to tend to fall in front, but the muscles of the neck steady it in its place. The hips incline forward, but are held erect by the strong muscles of the back. The trunk is nicely balanced on the head of the thigh-bones. The great muscles of the thigh acting over the knee-pan tend to bend the body forward, but the muscles of the calf oppose this action. The ankle, the knee, and the hip lie in nearly the same line, and thus the weight of the body rests directly on the key-stone of the arch of the foot. So perfectly do these muscles act that we

never notice them, and yet to learn how to use them in our infancy needed patient lessons, much time, and many hard knocks.

How We Walk.—Walking is really a perilous act, which has become safe only because of constant practice. Standing on one foot, we let the body fall forward, and swing the other leg ahead like a pendulum. Planting that foot on the ground, to save the body from falling further, we swing the first foot forward again to repeat the same operation. In walking, therefore, we have always one foot, and sometimes both feet on the ground. In running, we incline the body more, and so, as it were, fall faster, and there is an instant in each step when both feet are off the ground. We are shorter when walking or running than when standing still, because of this falling forward to take a step in advance.

Experiment.—Stand a boy erect against a wall. Mark his height with a stick. Now have him step off a part of a pace, and then several whole paces. Next, let him close his eyes, and walk to the wall again. He will be perceptibly lower than the stick, until he straightens up once more from a walking position.

The Muscular Sense.—When we lift an object, we feel a sensation of weight, which we can compare by lifting another object. We can cultivate this sense till we can estimate the weight of a body by simply balancing it on the palm of the right hand, that being generally more accurate than the left. Some parts of the body are more sensitive than others to differences in weight.

Experiment.—Roll a small ivory ball down your cheek toward your lips, and it will appear to increase in weight.

We gratify the muscular sense when we walk erect and with an elastic step, and by dancing, jumping, skating, and gymnastic exercises.

Necessity of Exercise.—By use, the muscles grow larger, and become hard, compact, and darker-colored; by disuse, they decrease in size, and become soft, flabby, and pale. Exercise also sets every organ in the body at work. The lungs, skin, and kidneys—the scavengers of the body—hasten to remove waste matter, and a healthful glow succeeds.

Violent Exercise, however, is injurious, since we then tear down faster than nature can build up. Feats of strength are not only hurtful, but dangerous. Often the muscles are strained or ruptured, and blood-vessels burst in the effort to outdo one's companions. Even so simple an amusement as jumping the rope, carried to excess, has been known to cause sudden death.

Time for Exercise.—Do not exercise when very hungry, nor immediately after a full meal. Only the strong and healthy should exercise before breakfast, as in early morning the pulse is low, the skin relaxed, and the system susceptible to cold. Weak and delicate persons, therefore, need to be braced with food before they brave the out-door air.

Kind of Exercise.—For children, the out-door games are unequaled. *Walking* in the open air and sunlight is always healthful. *Running* is better, since it employs more muscles, but it must not be pushed to excess, as it taxes the heart. *Rowing* develops the whole system. *Swimming*, also, employs all the muscles, and is a valuable acquirement,

as it may be the means of saving life. *Horseback riding* is a fine accomplishment, and refreshes mind and body alike. *Gymnastic or calisthenic movements,* judiciously used, furnish the best in-door exercise.

The Law of Health is to *take daily, moderate out-door exercise, avoiding extreme fatigue.* It is bad policy to stimulate the brain at the expense of the muscles, and recesses should be as sacred to play as study-hours are to work.

The Wonders of the Muscles.—The grace, ease, and rapidity with which the muscles contract are astonishing. The voice may utter 1,500 letters in a minute, yet each requires a distinct position of the vocal organs. We train the muscles of the fingers till they glide over the keys of the piano, executing the most exquisite and difficult harmony. In writing, each letter is formed by its peculiar motions, yet we make them so unconsciously that a skilful penman will describe beautiful curves while thinking only of the idea that the sentence is to express. The mind of the violinist is upon the music which his right hand is executing, while his left determines the length of the string and the character of each note so carefully that not a false sound is heard, although the variation of a hair's breadth would cause a discord. In the arm of a blacksmith, the biceps muscle may grow into the solidity almost of a club; the hand of a prize-fighter will strike a blow like a sledge-hammer: while the engraver traces lines invisible to the naked eye, and the fingers of the blind acquire a delicacy that almost supplies the place of the missing sense.

Diseases.—1. ST. VITUS'S DANCE is a disease of the voluntary muscles, whereby they are in frequent, irregular, and spasmodic motion beyond the control of the will. It is closely connected with a derangement of the nervous system, and hence the patient should be kept from excitement, and his general health invigorated.

2. LOCKED-JAW is marked by spasms and a contraction of the muscles, usually beginning in the lower jaw. It is serious, often fatal, yet may be caused by as trivial an injury as the stroke of a whip-lash, the lodgment of a bone in the throat, a fish-hook in the finger, or a prick in the foot by a tack.

3. GOUT is an acute pain located chiefly in the small joints of the foot, especially those of the great toe, which swell and become extremely sensitive. It is generally brought on by high living.

4. RHEUMATISM affects mainly the connective, white, fibrous tissue of the larger joints. There are two common forms—the inflammatory or acute, and the chronic. The acute form is probably a disease of the blood, which carries with it some poisonous matter that is deposited where the fibrous tissue is most abundant. The pain is extreme, the disease flies from one joint to another, and there is always danger that it may go to the heart. All violent remedies, therefore, are to be avoided. Repeated acute attacks lead to the chronic form, and make the patient a life-long sufferer.

PRACTICAL QUESTIONS.

1. Describe the motions of the bones when we are using a gimlet.
2. Why do we tire when we stand erect?
3. Why does it rest us to change our work?
4. Why and when is dancing a beneficial exercise?
5. Why do we lean forward when we wish to rise from a chair?
6. Why does the projection of the heel-bone make walking easier?
7. Does a horse travel with less fatigue over a flat than a hilly country?
8. Can you move your upper jaw?
9. Are people naturally right or left handed?
10. Why can so few persons move their ears by the muscles?
11. Is the blacksmith's right arm healthier than the left?

12. Boys often, though foolishly, thrust a pin into the flesh just above the knee. Why is it not painful?

13. Will ten-minutes practice in a gymnasium answer for a day's exercise?

14. Why would an elastic tendon be unfitted to transmit the motion of a muscle?

15. When one is struck violently on the head, why does he instantly fall?

16. What is the cause of the difference between light and dark meat in a fowl?

BLACKBOARD ANALYSIS.

THE MUSCLES.

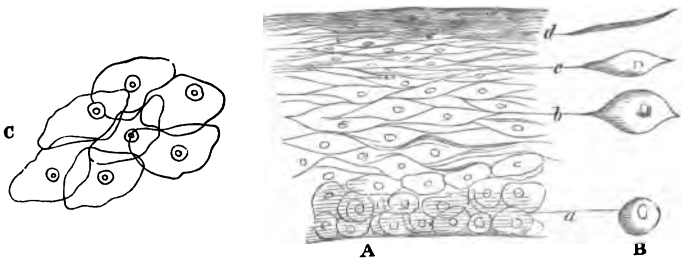
1. THE USE, STRUCTURE, AND ACTION OF THE MUSCLES.
    1. The use of the muscles.
    2. Contractility of the muscles.
    3. Arrangement of the muscles.
    4. The two kinds of muscles.
    5. The structure of the muscles.
    6. The tendons for fastening muscles.
    7. The effect of big joints.
    8. Action of the muscles in standing.
    9. Action of the muscles in walking.
2. THE MUSCULAR SENSE.
3. HYGIENE OF THE MUSCLES.
    1. Necessity of Exercise.
    2. Violent Exercise.
    3. Time for Exercise.
    4. Kinds of Exercise.
    5. Law of Health.
4. WONDERS OF THE MUSCLES.
5. DISEASES.
    1. St. Vitus's Dance.
    2. Locked-jaw.
    3. Gout.
    4. Rheumatism.

THE SKIN.

THE **Skin** is a tough, thin, close-fitting, elastic garment which protects the tender flesh. It is, also, an active organ, doing its part to keep in order the house in which we live. It oils itself to preserve its smoothness and delicacy, replaces itself as fast as it wears out, and is at once the perfection of use and beauty.

Cutis and Cuticle.—What we commonly call the skin—viz., the part raised by a blister—is only the cuticle, which covers the cutis or true skin. The

Fig. 18.



A *represents a vertical section of the cuticle;* B, *lateral view of the cells;* C, *flat side of scales like* d, *magnified 250 diameters, showing the nucleated cells transformed into broad scales.*

cutis is full of nerves and blood-vessels, but the cuticle neither bleeds nor causes pain, neither suffers from heat nor feels the cold.

Experiment.—Run a needle through the thick cuticle at the root of your finger-nail, and note its insensibility.

The cuticle is composed of small, flat cells or scales. These are constantly shed from the surface in the form of scurf, dandruff, etc., but are as constantly renewed from the cutis below.

Value of the Cuticle.—In the palm of the hand, the sole of the foot, and other parts especially liable to injury, the cuticle is very thick. This is an admirable provision for their protection. By use, it becomes callous and horny. The boy who goes out barefoot for the first time, "treading as if on eggs," can soon run where he pleases among thistles and over stones. So the blacksmith handles hot iron, and the mason works in lime, without burning or corroding their flesh.

The Complexion.—In the freshly-made cells on the lower side of the cuticle, is a pigment composed of tiny grains. In its varying tint lies the difference of hue between the blonde and the brunette, the European and the African. The sun has a powerful effect upon the coloring-matter, and so we "tan" on exposure to its rays. If the color gathers in spots, it forms freckles.

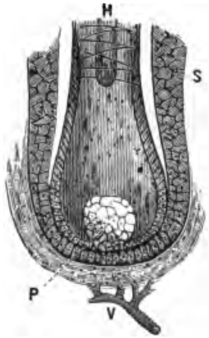
HAIR AND NAILS.

The Hair and the Nails are modified forms of the cuticle.

The Hair protects from heat and cold, and shields the head from blows.

Experiment.—Place a hair on the slide of a microscope, cover it with a thin glass, and let a few drops of alcohol flow between the cover and the slide. (This causes the air, which fills the hair and prevents our seeing its structure, to escape.) You will see that the outside of the hair is hard and compact, and consists of a layer of colorless scales, which overlie one another like the shingles of a house. The interior is porous, and probably conveys the liquids by which it is nourished.

Fig. 19.



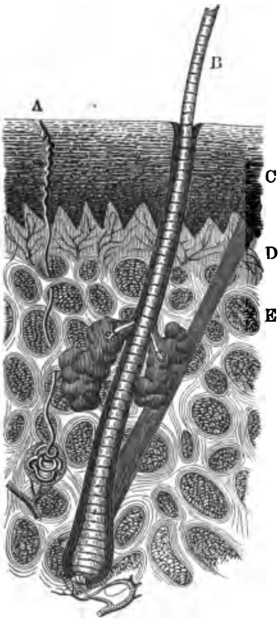
A hair magnified 600 diameters. S, *the sac (follicle)*; P, *the papilla, showing the cells and the blood-vessels* (V).

Each hair grows from a tiny bulb (papilla), at the bottom of a little hollow in the skin, being produced, like the cuticle, by the constant formation of new cells at its base. The hair itself is insensible, and the pain felt when one is pulled out comes from nerves in the hollow wherein it is rooted. If the bulb has been uninjured in the pulling, it will produce a new hair; but, the bulb destroyed, the hair will never grow again. Gray hair cannot be restored to its original color. Hair-dyes and so-called "hair-restorers" are usually injurious substances, containing lead or lunar caustic.

Wherever hair exists, are found tiny muscles, which contract when exposed to cold, pucker up the skin, and so cause the hair to stand on end. This muscular tissue is still more fully developed in horses and other animals, which we see shaking the whole skin, in order to drive away flies.

The Nails protect the ends of the tender finger, and toe, and give us more power to grasp and pick up objects. By their aid, we perform a hundred

Fig. 20.



A, *a perspiratory tube with its gland;* B, *a hair with a muscle and two oil-glands;* C, *cuticle;* D, *the papillæ;* and E, *fat-cells.*

little mechanical acts which else were impossible. Their delicate color and beautiful outline give a finish of ornament to the hand. The nail is set in a groove in the cuticle, and grows at the root in length, and from beneath in thickness.

Experiment.—Make a little mark near the root of a nail. You can see, week by week, how the process of growth goes on, and form some idea of what a multitude of cells must be transformed into horny matter.

THE MUCOUS MEMBRANE.

Structure.—At the edges of the openings into the body, the skin seems to stop, giving place to a redder, more sensitive tissue, moistened by a fluid (mucus). Really, however, the skin does not cease, but passes into a more delicate covering of the same general composition, viz., an outer, hard, bloodless, insensible layer, and an inner, soft, nervous one.

Connective Tissue.—The cutis and the corresponding layer of the mucous membrane consist chiefly of a fibrous substance, called connective tissue because it connects all the different parts of the body. In the mucous membrane it is soft and tender, but

in the ligaments and tendons it is strong and dense. It yields gelatine on boiling, and is the part which tans when hides are manufactured into leather.

Experiment.—Note in a piece of veal this delicate substance between the layers of muscle, binding together their numerous fibers. If you blow air into the veal, it will fill the tiny cells of the tissue and make the meat look plump—a trick not unknown, it is said, to butchers.

Uses of Membrane.—Our bodies are wrapped in membrane. On the outside, the skin protects from exterior injury, and, on the inside, the mucous membrane reaches from the lips to the innermost air-cell of the lungs. Every organ is enveloped. Every bone has its sheath. Every socket is lined. Even the separate fibers of muscles are covered with tissue. The brain and the spinal cord are triply wrapped, while the eye is only a membranous globe filled with fluid. These membranes not only protect and support the organs they enfold, but they also perform an important function. "They are the *filters* of the body." Through their pores pass alike the elements of growth, and the returning products of waste. Bathed on one side by the blood, they choose from it suitable food for the organ they envelop, and, in their tiny, mysterious cells, even form new products, just suited to the needs of the body.

Fat is deposited as an oil in the cells of this tissue, just beneath the skin, giving plumpness to the body, and acting as a non-conductor to retain the heat. It collects as pads in the hollows of the bones, around the joints, and between the muscles, causing them to glide more easily upon each other. As marrow,

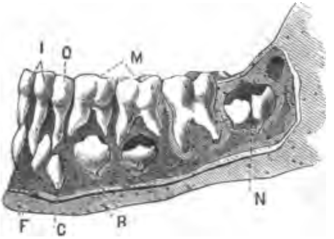
it nourishes the skeleton, and also distributes the shock of a sudden jar. It does not, however, gather within the lungs, or the eyelids, where it would clog the organs.

THE TEETH.

The Teeth are thirty-two in all,—there being eight in each half-jaw, similarly shaped and arranged. In each set of eight, the two nearest the middle of the jaw have wide, sharp, chisel-like edges, fit for cutting, and hence are called *incisors*. The next corresponds to the great tearing or holding tooth of the dog, and is styled the *canine*, or eye-tooth. The next two have broader crowns, with two points, or cusps, and are hence termed the *bicuspids*. The remaining three are much broader, and, as they are used to crush the food, are called the *grinders*, or *molars*. The incisors and eye-teeth have one fang, or root, the others have two or three each.

The Milk-teeth.—We are given two sets of teeth.

Fig. 21.

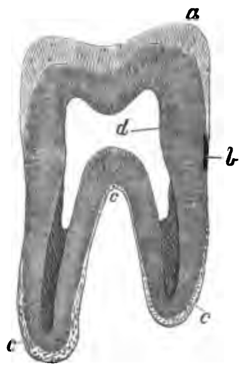


The teeth a the age of six and one-half years. I, *the incisors ;* O, *the canine ;* M, *the molars : the last molar is the first of the permanent teeth ;* F, *sacs of the permanent incisors ;* C, *of the canine ;* B, *of the bicuspids ;* N, *of the 2d molar ; the sac of the 3d molar is empty.*—MARSHALL.

The first, or milk-teeth, are small and only twenty in number. Each half-jaw has two incisors, one canine, and two molars. The middle incisors are usually cut about the age of seven months, the others at nine months, the first molars at twelve months, the canines at eighteen months, and the remaining molars at two or three years of age. The lower teeth precede the corresponding upper ones. The time often varies, but the order seldom.

The Permanent Teeth.—At six years, when the first set is usually still perfect, the jaws contain the crowns of all the second, except the wisdom-teeth. About this age, to meet the wants of the growing body, the crowns of the permanent set begin to press against the roots of the milk-teeth, which, becoming absorbed, leave the loosened teeth to drop out, while the new ones rise to occupy their places.

Fig. 22.



Vertical section of a Molar Tooth, moderately magnified. a, *enamel of the crown, the lines of which indicate the arrangement of its columns;* b, *dentine;* c, *cement;* d, *pulp cavity.*

The central incisors appear at about seven years of age; the others at eight; the first bicuspids at nine, the second at ten; the canines at eleven or twelve; the second molars at twelve or thirteen, and the last, or wisdom-teeth, are sometimes delayed until the twenty-second year or even later.

Structure of the Teeth.—A tooth consists of (1) the *crown*—protected by a hard, white *enamel;* (2)

dentine—a dense, bone-like substance; and (3), at its center, a soft, reddish-white pulp, full of nerves and blood-vessels. The fang is covered by a thin layer of bone (cement). The seat of toothache is in the sensitive pulp.

The Decay of the Teeth is commonly caused by bits of food which get between them and decompose; and (2) by the saliva which deposits a sediment called *tartar*.

Preservation of the Teeth.—The teeth should be brushed at least every morning with tepid water, and twice a week with soap and powdered orris-root. After each meal, every particle of food should be removed from between them, using a quill or wooden tooth-pick. The enamel once injured, it is never restored, and the tooth will soon decay. We should not, therefore, crack nuts, bite thread, or use metal tooth-picks, gritty tooth-powder, or any acid which "sets the teeth on edge," i. e., that acts upon the enamel. It is well to have the teeth examined yearly by a dentist.

THE GLANDS OF THE SKIN.

I. The Oil Glands are clusters of tiny sacs which secrete an oil that flows to the root of the hair, thence oozing out on the cuticle (Fig. 20). This is nature's hair-dressing, and it also keeps the skin soft and flexible. These glands are of considerable size on the face, especially about the nose. When obstructed, their contents become hard and dark-colored, and are vulgarly called "worms."

II. The Perspiratory Glands are fine tubes about $\frac{1}{300}$ of an inch in diameter, and a quarter of an inch in length, which run through the cutis, and then coil up in little balls (Fig. 20). In the palm of the hand, there are about 2,800 in a single square inch. The total number on the body of an adult is estimated at about two and a half million. If they were laid end to end, they would extend nearly ten miles.

Experiment.—Examine with a pocket lens the fine ridges on the palm of your hand, and you will see the mouths (*pores*) of these glands.

The Perspiration. — From these openings, there constantly passes a vapor, forming what we call the insensible perspiration. Under exercise or heat it flows more freely, and condenses on the surface in drops. It consists of about ninety-nine parts water, and one part solid matter. The amount thrown off by an adult is, on the average, about two pounds per day. This constant drainage is essential to life. A small animal, as the rabbit, if coated with varnish, would die within twelve hours.

HYGIENE.

About Washing and Bathing. — The cast-off cuticle, dried perspiration, and dust form a crust upon the skin, stopping the pores, checking the insensible perspiration, and retaining in the body the waste matter it ought to throw off. Hence arises the need of frequent bathing. Nothing is so good for improving the complexion, preventing colds, keeping up strength, and lengthening life.

The moment of rising from bed is the proper time for the full wash or bath with which one should commence the day. The body is then warm, and can endure cool water better than at any other time; it is relaxed, and needs bracing; and the nerves, deadened by sleep, require a gentle stimulus. If the system be strong enough to resist the shock, cold water is the best; if not, use tepid.

After the bath, the whole body should be thoroughly rubbed with a coarse towel or flesh-brush. At first, the friction may be unpleasant, but this sensitiveness will soon pass away, and the keenest pleasure be felt in the lively glow which follows. A bath should not be taken just before nor immediately after a meal, lest it check digestion.

Reaction.—After taking a cold bath, there should be a prompt reaction. When the surface is chilled by cold water, the blood sets to the heart, exciting it to more vigorous action; then, being thrown back to the surface, it reddens, warms, and stimulates the skin. This is called the reaction, and in it lies the chief virtue of a cold bath. In a hot bath, on the contrary, the blood is drawn to the surface, less blood goes to the heart, the circulation decreases, and languor ensues. It should be followed by a dash of cold water.

If, after a cold bath, we are chilly instead of warm, it proves either that proper means were not taken to bring on reaction, or that the circulation is not vigorous enough to warrant such a bath. In general, the effect of a cool bath is to exhilarate; of a warm one, to depress. Hence the latter should not ordi-

narily be taken oftener than once a week, while the former may be enjoyed daily.

Sea-Bathing is exceedingly stimulating, on account of the action of the salt and the exciting surroundings. Twenty minutes is the utmost limit for bathing or swimming either in salt or fresh water. A chilly sensation should be the signal for instant removal. Gentle exercise after a bath is beneficial.

Clothing in winter, to keep us warm, should repel the external cold and retain the heat of the body. In summer, to keep us cool, it should not absorb the rays of the sun, and should permit the passage of the heat of the body. At all seasons, it should be porous, to give ready escape to the perspiration, and a free admission of air to the skin. We can readily apply these essential conditions to the different kinds of clothing.

Linen is soft to the touch, and is a good conductor of heat. Hence it is pleasant for summer wear, but, being apt to chill the surface too rapidly, it should not be worn next the skin.

Cotton is a poorer conductor of heat and absorber of moisture, and is therefore warmer than linen. It is sufficiently cool for summer wear, and affords better protection against sudden changes.

Woolen absorbs moisture slowly, and contains much air in its pores. It is therefore a poor conductor of heat, and guards the wearer against changes in weather. Hence, flannel or merino should be worn next the skin at all times, except in the heat of summer, when cotton flannel or gauze may be substituted.

Light-colored clothing is cooler in summer, and warmer in winter. As the warmth of clothing depends greatly on the amount of air contained in its fibers, fine, porous cloth with a plenty of nap is best for winter wear. Furs are the perfection of winter clothing, since they combine warmth with lightness.

All the body except the head should be equally protected by clothing. No part covered to-day can be uncovered to-night or to-morrow, except at the peril of health. It is a cruel fashion that leaves the limbs of a little child unprotected. Nor are children made more hardy by going thinly clad. The system is made vigorous by exercise and food; not by exposure. Above all, the feet need heavy shoes with thick soles, and rubbers when it is damp. At night, and after exercise, we require extra clothing.

Diseases.—1. CORNS are a thickening of the cuticle, caused by pressure or friction. They most frequently occur on the feet; but are produced on the shoemaker's knee by constant hammering, and on the soldier's shoulder by the rubbing of his musket. This hard portion irritates the sensitive cutis beneath, and so causes pain. By soaking the feet in hot water, the corn will be softened, when it may be ~~paired~~ with a sharp knife.

2. IN-GROWING NAILS are caused by pressure, which forces the edge of the toe-nail into the flesh. To cure them, carefully cut away the malgrown part, and then make a wedge-shaped incision in the top of the nail. The two portions, uniting, will draw away the nail from the flesh at the edge. To prevent them, wear broad shoes.

3. WARTS are overgrown papillæ (Fig. 19). They may generally be removed by applying glacial acetic acid, or a drop of nitric acid, repeated until the entire wart is softened. Care must be taken to keep the acid from touching the neighboring skin. The capricious character of warts has given rise to the popular delusion concerning the influence of charms upon them.

4. CHILBLAIN is a local inflammation affecting generally the feet. Liability to it usually passes away with manhood. It is not caused by "freezing the feet," as many suppose, though attacks are brought on, or aggravated, by exposure to cold and by sudden warming. It is subject to daily congestion (see Congestion), manifested by soreness, itching, etc., commonly occurring at night. The best preventive is a uniform temperature, and careful protection against the cold by warm, loose, and plentiful clothing, especially for the feet.

PRACTICAL QUESTIONS.

1. If a hair be plucked out, will it grow again?
2. What causes the hair to "stand on end" when we are frightened?
3. Why is the skin roughened by riding in the cold?
4. Why is the back of a washer-woman's hand less water-soaked than the palm?
5. What would be the length of the perspiratory tubes in a single square inch of the palm, if placed end to end?
6. What colored clothing is best adapted to all seasons?
7. What is the effect of paint and powder on the skin?
8. Is water-proof clothing healthful for constant wear?
9. Why are rubbers cold to the feet?
10. Why does the heat seem oppressive when the air is moist?
11. Why is friction of the skin invigorating after a cold bath?
12. Why does the hair of domestic animals become roughened in winter?
13. Why do fowls shake out their feathers erect before they perch for the night?
14. Why do we perspire so profusely after drinking cold water?
15. What are the best means of preventing skin-diseases, colds, and rheumatism?
16. What causes the difference between the hard hand of a blacksmith and the soft hand of a woman?
17. Why should a painter avoid getting paint on the palm of his hand?
18. Why should we not use the soap or the soiled towel at a hotel?
19. Which teeth cut like a pair of scissors?
20. Which teeth cut like a chisel?

21. Which should be clothed the warmer, a merchant or a farmer?
22. Why should we not crack nuts with our teeth?
23. Do the edges of the upper and the lower teeth meet?
24. When fatigued, would you take a cold bath?
25. Why is the outer surface of a kid glove finer than the inner?
26. Why will a brunette endure the sun's rays better than a blonde?
27. Does patent-leather form a healthful covering for the feet?

BLACKBOARD ANALYSIS.

THE SKIN.

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RESPIRATION

AND

THE VOICE.

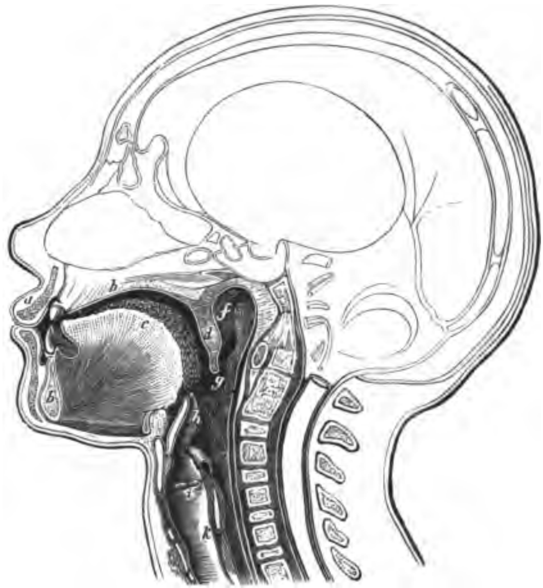
THE ORGANS of Respiration and the Voice are the *larynx*, the *trachea*, and the *lungs*.

Description of the Organs of the Voice.—1. THE LARYNX.—In the neck, is a lump sometimes called Adam's apple. It is the front of the *larynx*. This is a small, gristly box, placed at the top of the windpipe, just below the tongue. The opening into it from the throat is called the *glottis;* and the cover, the *epiglottis*. The latter is a spoon-shaped lid, which opens when we breathe, but shuts when we swallow, and so lets our food slip over it into the tube (œsophagus, *e-sof'-a-gus*) leading to the stomach (Fig. 23).

If we laugh or talk when we swallow, our food is apt to "go the wrong way," *i. e.*, little particles pass into the larynx, and the tickling sensation they produce forces us to cough, to expel the intruders.

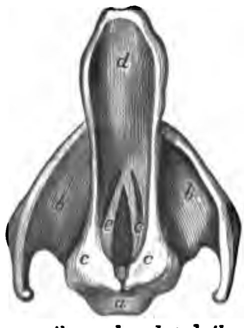
2. THE VOCAL CORDS.—On each side of the *glottis* are the so-called *vocal cords*. They are not really cords, but elastic membranes projecting from the

Fig. 23.



Passage to the Œsophagus and Windpipe; c, *the tongue;* d, *the soft palate, ending in* g, *the uvula;* h, *the epiglottis;* i, *the glottis;* I, *the œsophagus;* f, *the pharynx.*

Fig. 24.



e, e, *the vocal cords;* d, *the epiglottis,*

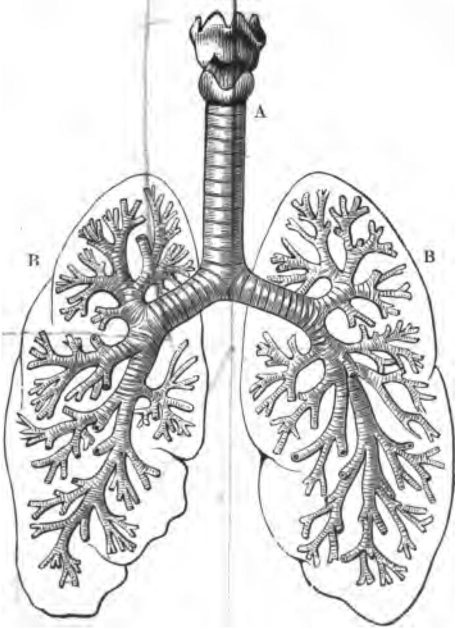
sides of the box across the opening. When not in use, they spread apart and leave a V-shaped orifice (Fig. 24), through which the air passes to and from the lungs. If the cords are tightened, the edges approach each other, and, being thrown into vibration, cause corresponding vibrations in the current of air. Thus sound is produced in

the same manner as by the vibrations of the strings of a violin, only in this case the strings are scarcely an inch long.

Experiment.—Ask your butcher for a sheep's larynx; trim off the flesh, and dry the cartilages. You can then examine at leisure the structure of the cords.

Different Tones of the Voice.—The higher tones of the voice are produced when the cords are short,

Fig. 25.



The Lungs, showing the Larynx. A, *the windpipe*; B, *the bronchial tubes.*

tight, and closely in contact; the lower in the opposite way. When boys are about fourteen years of

age, the larynx enlarges, and the cords grow proportionately longer and coarser; hence, the voice becomes deeper, or, as we say, "changes."

Formation of Vocal Sounds.—A vocal sound requires the action of the larynx. Speech is voice modified by the lips, tongue, palate, and teeth.

Experiments.—Open your mouth and make the pure vowel sounds a, e, i, etc., noting how the form of the aperture is changed for each vowel by the tongue and the lips. Then try the consonants. You will discover that *m* and *n* can be made only by blocking the air in the mouth and sending it through the nose; *l* lets the air escape at the sides of the tongue; *r* needs a vibratory movement of the tongue; *b* and *p* stop the breath at the lips, and *d* and *t*, at the back of the palate. Now place your hand on your throat, and note the absence of vibrations when you whisper, and their presence when you speak aloud. Continuing your experiments, you will find that a sigh is only a vocalized groan; that a laugh is a convulsive repeating of the vowels a, e, or o; and that a whistle is not a vocal but a pure mouth sound.

Fig. 26.

Bronchial Tubes, with clusters of cells.

Consonants made by the lips are termed *labials;* those by pressing the tongue against the teeth, *dentals;* those by the tongue, *linguals.* A child first learns to pronounce the vowel *a*, then the consonants *b*, *m*, and *p*, and afterward their unions—*ba*, *ma*, *pa*.

Description of the Organs of Respiration. — Beneath the larynx is the windpipe,

or *trachea* (Fig. 25). It is strengthened by *C*-shaped cartilages with the openings behind, where they are attached to the œsophagus. At the lower end, the trachea divides into two branches, called the right and left *bronchi*. These subdivide in the small bronchial tubes, which ramify through the lungs like the branches of a tree, the tiny twigs of which at last end in clusters of cells so small that there are 600,000,000 in all. Along the air-passages are tiny thread-like projections (*cilia*). These are constantly waving to and fro, and serve as a screen to catch the dust swept in with the breath.

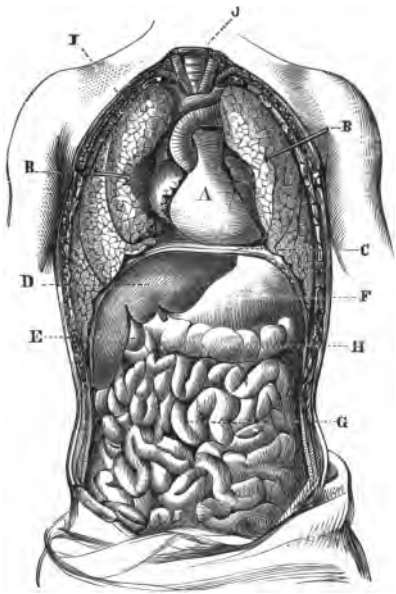
Experiment.—Procure the lungs (vulgarly called "lights") of some slaughtered animal. Insert a quill in the windpipe, and inflate them. Notice how soft and sponge-like is the structure. See how they will float on water. Then squeeze a bit between your fingers and note the creaking sound.

Wrappings of the Lungs.—The lungs are wrapped in a double membrane (the *pleura*) one layer being attached to the lungs and the other to the walls of the chest. This secretes a lubricating fluid, making the layers glide upon each other with ease.

How we Breathe.—Respiration consists of two acts—taking in the air, or *inspiration*, and expelling the air, or *expiration*.

1. Inspiration.—When we draw in a full breath, we straighten the spine and throw the head and shoulders back, so as to give the greatest advantage to the muscles. At the same time, the diaphragm —the muscular partition between the chest and the abdomen (C, Fig. 27)—descends and presses the walls

Fig. 27.



A, *the heart;* B, *the lungs drawn aside to show the internal organs;* C, *the diaphragm;* D, *the liver;* E, *the gall cyst;* F, *the stomach;* G, *the small intestine;* H, *the transverse colon.*

of the abdomen outward. Both these processes increase the size of the chest. Thereupon, the elastic lungs expand to occupy the extra space, while the air, rushing in through the windpipe, pours along the bronchial tubes, and crowds into every cell.

2. Expiration.—When we forcibly expel the air from our lungs, the operation is reversed. We bend forward, draw in the walls of the abdomen, and press the diaphragm upward, while the ribs are

pulled downward,—all together diminishing the size of the chest, and forcing the air outward.

Ordinary, quiet breathing is performed mainly by the diaphragm,—one breath to every four beats of the heart, or eighteen per minute.

Modifications of the Breath.—*Coughing* is a violent expiration in which the air is driven through the mouth. *Sneezing* differs from coughing, the air being forced through the nose. *Snoring* occurs when the air passes through both nose and mouth, while the palate flaps in the divided air-current, and so throws it into vibration. *Laughing* and *crying* are very much alike. The expression of the face is necessary to distinguish between them. The sounds are produced by short, rapid contractions of the diaphragm. *Hiccough* is confined to inspiration. It is caused by a contraction of the diaphragm and a sudden closing of the glottis ; the entering current of air strikes the closed glottis and gives rise to the well-known sound.

The Capacity of the Lungs.—If we take a deep inspiration, and then forcibly exhale all the air we can expel from the lungs, this amount, termed the *breathing capacity,* will be, for a man of average height, about 230 cubic inches, or one gallon. In addition, it is found that the lungs contain about 100 cubic inches which cannot be expelled, thus making their entire contents about 330 cubic inches, or eleven pints. In ordinary breathing, only about twenty or thirty cubic inches (less than a pint) of air pass in and out.

The Need of Air—The body needs food, clothing,

sunshine, bathing, and drink; but above all these is the need for air. The other wants may be met by occasional supplies, but air must be furnished every moment or we die.

Air consists of one-fifth oxygen, and four-fifths nitrogen. The active and vital element is oxygen. Taken alone, this would be too stimulating, but the passive nitrogen restrains it. No tonic is so refreshing as a few full, deep breaths of cold pure air, which sets every organ aglow with the energy of the fiery oxygen gas.

Action of the Air in the Lungs.—In the delicate cells of the lungs, the air gives up its oxygen to the blood, and receives in turn carbonic-acid gas and water, foul with waste matter which the blood has picked up in its circulation through the body. The blood, thus purified and laden with the inspiring oxygen, goes bounding through the system, while the air we exhale carries off the impurities. In this process, the blood changes from purple to red.

Experiments.—1. Breathe into a jar, and lower into it a lighted candle. The flame will be instantly extinguished, thus indicating the presence of carbonic-acid gas. 2. Breathe upon a mirror, and a film of moisture will show the vapor. 3. Confine a breath in a bottle. The animal matter will soon decompose and give off an offensive odor.

Analysis of the Expired Air shows that it has lost about one-fourth of its oxygen, and gained an equal amount of carbonic-acid gas, besides moisture, and organic impurities. Our breath, then, is air robbed of its vitality, and containing in its place a gas as fatal to life as it is to a flame, and effete matter

which is disagreeable to the smell, injurious to the health, and may contain the germs of disease.

The Evil Effect of Rebreathing the air cannot be over-estimated. We take back into our bodies that which has just been rejected, and the blood leaves the lungs, bearing, not invigorating oxygen, but refuse matter to obstruct the whole system. We soon feel the effect. The muscles become inactive; the blood stagnates; the heart acts slowly; the food is undigested; the brain is clogged; and the head aches.

The constant breathing of even the slightly-impure air of our houses tends to undermine health. The unpurified blood is ready to receive the seeds of disease. The system, deprived of the inspiring oxygen, is sensitive to cold. Pale cheeks, lusterless eyes, languid steps, speak but too plainly of oxygen starvation. In such a soil, catarrh, scrofula, and consumption run riot.

Concerning the Need of Ventilation.—The impurities which pass off from the lungs and through the pores of the skin do not fall to the floor, but diffuse themselves through the surrounding atmosphere. A single bad breath will taint the air of a whole room. A light will vitiate as much air as a dozen persons. Many breaths and lights, therefore, rapidly unfit the air for our use.

The perfection of ventilation is reached when the air of a room is as pure as that out of doors. To accomplish this result, we must allow for each person 600 cubic feet of space, besides providing thorough ventilation.

In spite of these well-known facts, scarcely any pains are taken to supply fresh air, while the doors and windows where the life-giving oxygen might creep in are carefully stopped.

THE SICK ROOM is often kept carefully closed. Yet here the danger of bad air is intensified. The expired breath of the patient is dangerous to himself as well as to others. Nature is seeking to throw off the poison of the disease. The scavengers of the body are all at work, and the breath and the insensible perspiration are loaded with impurities.

Experiment.—When the sun is shining through a crack in the blinds of a darkened room, watch the line of floating dust. This shows how poisonous germs are frequently conveyed to our lungs. When a scarlet-fever patient is uncovered, a cloud of such fine dust will rise from his body, and will keep its contagious properties for days.

OUR SITTING-ROOMS, heated by furnaces or red-hot stoves, frequently have no means of ventilation, or, if provided, they are seldom used. A window is occasionally dropped to give a little relief, as if pure air were a rarity, and must be doled out to the suffering lungs in morsels, instead of full and constant draughts. The inmates are starved by scanty lung-food, and stupefied by foul air. The process goes on year by year. The weakened and poisoned body at last yields to disease. Death is often simply the penalty for violating nature's laws. Bad air begets disease; disease begets death.

IN OUR CHURCHES, the foul air left by the congregation on Sunday is shut up during the week, and heated for the next Lord's day, when the people assemble to re-breathe the polluted atmosphere.

They are thus forced, with every breath they take, to violate the physical laws of Him whom they meet to worship,—laws written not 3000 years ago upon Mount Sinai on tables of stone, but to-day engraved in the constitution of their own living, breathing bodies. On brains benumbed and starving for oxygen, the purest truth and the highest eloquence fall with little force.

BED-ROOM VENTILATION.—We sleep in a small bedroom from which every breath of fresh air is excluded, because we fancy that all night-air is unhealthy, and so we breathe its dozen hogsheads of air over and over again, and then wonder why we awaken in the morning so dull and unrefreshed! Return to our room after inhaling the fresh, morning air, and the fetid odor we meet on opening the door, is convincing proof how we have poisoned our lungs during the night. There is a singular prejudice against the night-air. Yet, as Florence Nightingale aptly says, what other air can we breathe at night? In large cities, night-air is often more wholesome than that of the day-time.

Every room needs 2000 feet of fresh air per hour for every person it contains. Our ingenuity ought to find some way of supplying this want. A part of the care we devote to delicate articles of food, drink, and dress would abundantly meet this prime necessity of our bodies.

Open the windows both at the top and the bottom. You need never fear the fresh night-air, except, perhaps, in extreme damp weather, or in places where malaria is known to exist. Put on plenty of clothing

to keep warm by day and by night, and then let the inspiring oxygen come in as freely as God has given it. Pure air is the cheapest necessity and luxury of life. Let it not be the rarest!

SCHOOL-ROOM VENTILATION.—Who, on going from the open air of a clear, bracing winter's day, into a crowded school-room, late in the session, has not noticed the disagreeable odor, and been for a moment nauseated and half-stifled by the oppressive atmosphere? It is not strange. See how many causes here combine to pollute the air. If the room is heated by a stove, quantities of carbonic-acid gas, driven by downward drafts in the flue, escape through seams, and cracks, and the occasionally-opened door of the stove. In the case of a furnace, the same effect is too often experienced, and the odor of coal-gas is a common one, especially when the fire is replenished. The insensible perspiration is more active in children than in adults; they, moreover, rush in with their clothing saturated with the perspiration induced by their sports; so that, on the average, each pupil, during school hours, loads the air with about half-a-pint of aqueous vapor. Some of the children come from homes that are close, ill-ventilated, and uncleanly; some from sick-rooms, whence they bring in their clothing the germs of disease; and some may themselves bear traces of illness, or have unsound organs, and so their breath and exhalations be poisonous.

In addition, the air is filled with dust brought in and kept astir by many busy feet; by ashes from the stove or furnace; and especially by chalk-dust.

The modern method of teaching requires a large amount of black-board work, and the air of the school-room is thus loaded with chalk-particles. These collect in the nasal passages and the upper part of the larynx, and irritate the membrane, perhaps laying the foundation of catarrh.

The usual school-room atmosphere bears the natural fruit of frequent headaches, inattention, weariness, and stupor. Instead of six hundred feet of space being allowed for each pupil, as perfect ventilation demands—the lowest estimate being 250 feet—often not over one hundred feet are afforded. Instead of 2000 cubic feet of fresh air for each pupil being supplied and as much foul air removed every hour,—the amount needed for perfect health—perhaps no means of ventilation at all are provided, and an occasionally opened door, and the benevolent cracks and chinks in the building, furnish the sole relief for the suffering lungs.

How Shall We Ventilate?—The usual method of ventilation depends upon the fact that hot air, being lighter than cold air, tends to rise, and the cold air sinks to take its place.

Experiments.—1. Open the door of a heated room, and hold a lighted candle first at the top, and then at the bottom. You can see, by the bending of the flame, that there is a current of air setting outward at the top, and another setting inward at the bottom of the opening. 2. Hold a handkerchief loosely in front of a fire-place, and it will be drawn strongly toward the opening; or, if you hold there a smoldering paper, the smoke will ascend the flue,—both being caused by the difference of temperature between the air in the room and the outside atmosphere. *Upon this difference of temperature all ordinary ventilation is based.*

A proper treatment of this subject and its practical applications would require a book by itself. There is room here for only a few general statements and suggestions.

1. Two openings are always necessary to produce a thorough change of the air.

Experiments.—(1.) Put a lighted candle in a bottle. The flame will soon be extinguished. The oxygen of the little air in the bottle is burned out, and carbonic acid has taken its place. (2.) Now place over the mouth of the bottle a lamp-chimney, and insert in the chimney a strip of card-board, thus dividing the passage. On relighting the candle, it will burn freely. The smoke of a bit of smoldering paper will show that two opposite currents of air are established, one setting into the bottle, the other outward.

2. In the winter, when our school-rooms, churches, etc., are heated artificially, the required difference of temperature is kept up with little difficulty. The fresh air admitted to the room should then be heated either by a furnace, or by passing over a stove, or through a coil of steam-pipes. This cold air should always be taken directly from out-doors, and not from a cellar, or under a piazza, where contamination is possible. In order to remove the impure air, there should be ventilators provided at or near the floor, opening into air-shafts or pipes leading upward through the roof, having proper orifices at the top. These ventilating-pipes should be heated artificially so as to produce a draft.

3. In the summer, ventilation may be commonly provided for by opening windows *at the top and the bottom*, on the sheltered side of the building, so as to avoid drafts of air injurious to the occupants. On a dull, still, hot day, when there is little difference of temperature between the inner and the outer air, ventilation can be secured only by having a fire provided in the ventilating shaft; this, by exhausting the air from the room, will cause a fresh current to pour in through the open windows. At recess, if the weather permit, all the children should be sent out-doors, to allow the clothing to be exposed to the purifying influence of the open air, and the windows should be thrown wide open, to ventilate the room thoroughly. In bad weather, rapid marching or calisthenic exercises will furnish exercise, and also permit the airing of the room.

4. The school and the church are the centers for spreading contagious diseases. The former is especially dangerous, and therefore great pains should be taken to exclude pupils attacked by or recovering from diph-

theria, scarlet-fever, whooping-cough, etc., and even those who live in houses where such sickness exists.

5. In our houses, the air is often contaminated by decaying vegetables and other filth in the cellar; by bad air drawn up into the cellar from the soil, in consequence of the powerful draughts that our fires create; by defective gas and waste-pipes that let the foul air from cesspool or sewer spread through the house; and by piles of refuse, or puddles of slops emptied at the back-door. At the same time, the water in our wells, or in streams that supply our towns and cities, receives too often the drainage from out-houses and barn-yards, and so aids in introducing the most dangerous poisons into our systems.

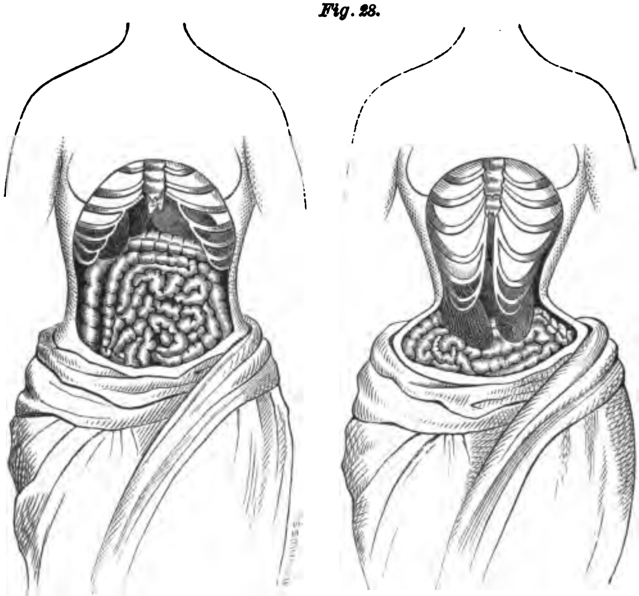
Open fire-places should be common, since they are efficient ventilators; they should never be closed for any cause. Fresh air admitted by a hot-air register and impure air passed out by a chimney, form a simple and thorough system. Our sleeping-apartments demand especial care. As soon as the occupants leave the room, the bed-clothes should be removed, and laid on the backs of chairs to air; the bed be shaken up; and the windows thrown wide open. In the summer, the windows may be closed before the sun is high; the house is then left filled with the cool morning air. In damp and cold weather, a fire should be lighted in sleeping-apartments, particularly if used by children or delicate persons, in order to dry the bed-clothing, and also to prevent a chill on the part of the occupants.

Wonders of Respiration.—The perfection of the organs of respiration challenges our admiration. So delicate are they that the least pressure would cause exquisite pain, yet tons of air surge to and fro through their intricate passages, and bathe their innermost cells. We yearly perform at least 7,000,000 acts of breathing, inhaling 100,000 cubic feet of air, and purifying over 3,500 tons of blood. This gigantic process goes on constantly, never wearies or worries us, and we wonder at it only when science reveals to us its magnitude. In addition, by a wise economy, the process of respiration is made to subserve

a second use no less important, and the air we exhale, passing through the organs of voice, is transformed into prayers of faith, songs of hope, and words of social cheer.

Diseases.—1. CONSTRICTION OF THE LUNGS is produced by tight clothing. The ribs are thus forced inward, the size of the chest is dimin-

Fig. 28.



A. B.

A, *the natural position of the internal organs.* B, *when deformed by tight lacing.* MARSHALL *says that the liver and the stomach have, in this way, been forced downward almost as low as the pelvis.*

ished, and the amount of inhaled air decreased. Stiff clothing, and especially a garment that will not admit of a full breath without inconvenience, will prevent that free movement of the ribs so essential to health. Any violation of the laws of respiration, even though it be fashionable, will surely result in diminished vitality and vigor.

2. Pneumonia (*pneuma*, breath) is an inflammation of the lungs, affecting chiefly the air-cells.

3. Consumption is a disease which destroys the substance of the lungs. Like other lung difficulties, it is caused largely by a want of pure air, a liberal supply of which is the best treatment that can be prescribed for it.

4. Diphtheria (*diphthera*, a membrane) is a kind of sore-throat, in which matter exudes from the mucous membrane. This stiffens into a peculiar white substance, which appears in patches. Fever and debility accompany this disease, which is so rapid and insidious in its advances as to be exceedingly dreaded.

5. Croup is an inflammation of the mucous membrane of the larynx and trachea. The attack frequently comes on suddenly, and usually in the night. It is accompanied by a peculiar "brassy," ringing cough, which, once heard, can never be mistaken. It may prove fatal within a few hours. (See Appendix.)

6. Stammering depends, not on defects of the muscles, but on a want of due control of the mind. When a stammerer is not too conscious of his lack, and tries to form his words slowly, he speaks plainly, and may sing well, for then his words must come in time. The stammerer should find out his peculiar difficulty, and overcome it by exercise, and especially by speaking only after a full inspiration.

PRACTICAL QUESTIONS.

1. What is the philosophy of "the change of voice" in a boy?

2. Why can we see our breath on a frosty morning?

3. When a law of health and a law of fashion conflict, which should we obey?

4. If we use a "bunk" bed, should we pack away the clothes when we first rise in the morning?

5. Why should a clothes-press be well ventilated?

6. Should the weight of our clothing hang from the waist, or the shoulder?

7. Describe the effects of living in an overheated room.

8. What habits impair the power of the lungs?

9. For full, easy breathing in singing, should we use the diaphragm and lower ribs, or the upper ribs alone

10. Why is it better to breathe through the nose than the mouth?

11. Why should not a speaker talk while returning home on a cold night after a lecture?

12. What part of the body needs the loosest clothing?

13. What part needs the warmest?

14. Why is a "spare bed" generally unhealthful?

15. Is there any good in sighing?

16. Should a hat be thoroughly ventilated? How?

BLACKBOARD ANALYSIS.

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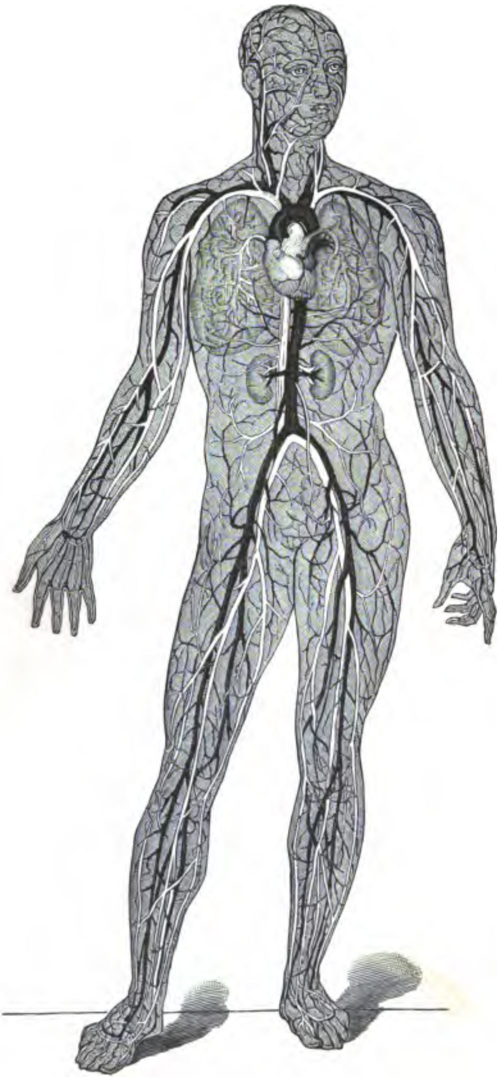
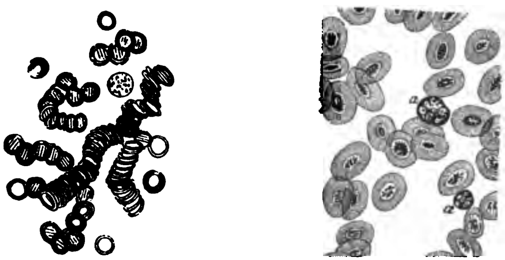


THE CIRCULATION.

THE **Organs of the Circulation** are the *heart*, the *arteries*, the *veins*, and the *capillaries*.

The Blood is the liquid by means of which the circulation is effected. It permeates every part of the body, except the cuticle, nails, hair, etc. The average quantity in each person is about eighteen pounds. It is composed of a thin, colorless liquid

Fig. 29.



A. B.

A, corpuscles of human blood, highly magnified; B, corpuscles in the blood of an animal (a non-mammal).

(*plasma*), filled with red disks, or cells, so small that 3,500 placed side by side would measure only about an inch. They have a tendency to collect in piles like rolls of coin. The size and shape vary in the blood of different animals. Disks are continually

forming in the blood, and as constantly dying—20,000,00O at every breath.—(*Draper*).

Experiment.—Get a drop of blood by pricking the end of your finger with a needle. Place it on the slide, cover with a glass, and put it at once under the microscope. You will see that the red disks group themselves in rows, while the white disks—of which there is only one to every three or four hundred red ones—will seem to draw apart, and to change their form continually.

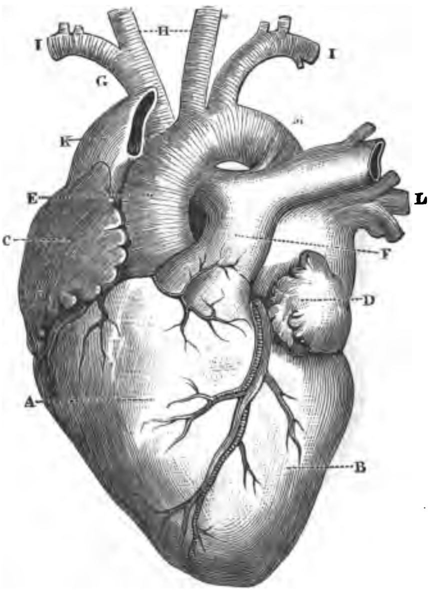
The plasma also contains fibrin, albumen—which is found nearly pure in the white of an egg—and also various mineral substances, as iron, lime, magnesia, phosphorus, potash, etc.

Uses of the Blood.—The blood has been called "liquid flesh"; but it is more than that, since it contains the materials for making every organ. The plasma is rich in mineral matter for the bones, and in albumen for the muscles. The red disks are the air-cells of the blood. They contain the oxygen so essential to every operation of life. Wherever there is work to be done or repairs to be made, there the oxygen is needed. It stimulates to action, and tears down all that is worn out. In this process, it combines with and actually burns out parts of the muscles and other tissues, as wood is burned in the stove. The blood, now foul with the burned matter, the ashes of this fire, is caught up by the circulation, and whirled back to the lungs, where it is purified, and again sent bounding on its way.

Coagulation.—When blood is exposed to the air, it coagulates. This is caused by the solidifying of the fibrin, which, entangling the disks, forms the "clot." The remaining clear, yellow liquid is the *serum.*

The coagulation soon checks all ordinary cases of bleeding. When a wound is made, and bleeding commences, the fibrin forms a temporary plug, as it were, which is absorbed when the healing process is finished. Thus we see how a Divine foresight has provided not only for the ordinary wants of the body, but also for the accidents to which it is liable.

Fig. 30.



The Heart. A, *the right ventricle;* B, *the left ventricle;* C, *the right auricle;* D, *the left auricle;* M, *the Aorta.*

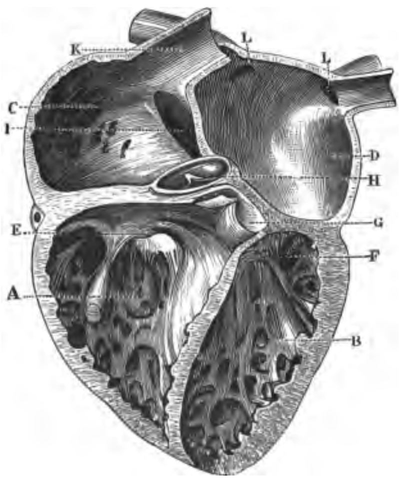
The Heart is the engine which propels the blood. It is a hollow, pear-shaped muscle, about the size of the fist. It hangs, point downward, just to the left of the center of the chest (Fig. 27). It is enclosed in

a loose sac of membrane (the *pericardium*), that is smooth as satin.

The Movements of the Heart consist of an alternate contraction and expansion. These constitute the beating of the heart which we hear so distinctly between the fifth and sixth ribs.

Experiment.—Place your ear over another person's heart. You can detect two sounds; the first, as the blood is leaving the heart; the second, as it falls into the pockets of the arteries, and the valves strike together. During the first, the two ventricles contract; during the second, the two auricles.

Fig. 31.



Chambers of the Heart. A, *right ventricle;* B, *left ventricle;* C, *right auricle;* D, *left auricle;* E, *tricuspid valve;* F, *bicuspid valve;* G, *semi-lunar valves;* H, *valve of the aorta;* I, *inferior vena cava;* K, *superior vena cava;* L, L, *pulmonary veins.*

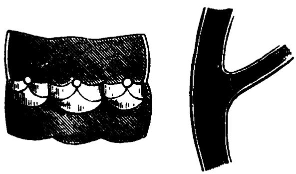
The Auricles and Ventricles.—The heart is divided into four chambers. In an adult, each holds about a wine-glassful. The upper ones, from appendages

on the outside resembling the ears of a dog, are called *auricles* (*aures*, ears); the lower ones are termed *ventricles*. The auricle and ventricle on each side communicate with each other, but the right and left halves of the heart are entirely distinct, and perform different kinds of work. The left side propels the red blood; and the right, the dark.

The auricles are merely reservoirs to receive the blood, and to furnish it to the ventricles as they need. Their work being light, their walls are thin and weak. On the other hand, the ventricles force the blood, and are, therefore, made very strong. As the left ventricle drives the blood so much further than the right, it is thicker and stronger.

Need of Valves in the Heart.—As the auricles do not need to contract with much force simply to empty their contents into the ventricles below them, there is no demand for any special contrivance to prevent the blood from setting back the wrong way. But, when the strong ventricles contract, some arrangement is necessary to prevent its escaping into the auricle again. Besides, when they expand, the "suction power" would tend to draw back again from the arteries all the blood just forced out. This difficulty is obviated by little doors, or valves, which will not let the blood go the wrong way.

Fig. 32.



Valves of the Veins.

Experiment.—The heart of an ox or a sheep may be used to show the chambers and valves. The aorta (see Fig. 30 and p. 75) should be cut as

far as possible from the heart, and then, by pumping in water, the perfection of the valves will be finely exhibited. The ingenious pupil will devise a method of illustrating the circulation of the blood as represented in Fig. 34, and thus obtain a clear idea of the action of this complex muscular organ—the heart.

The Tricuspid and Bicuspid Valves.—At the opening into the right ventricle, is a valve consisting of three folds or flaps of membrane, whence it is called the *tri-cuspid* valve (*tri*, three; and *cuspides*, points), and in the left ventricle, one containing two flaps, and named the *bi-cuspid* valve. These hang so loosely as to oppose no resistance to the passage of the blood into the ventricles; but, if any attempts to go the other way, it gets between the flaps and the walls of the heart, and, driving them outward, closes the orifice.

The Semi-lunar Valves.—In the passages outward from the ventricles, are the *semi-lunar* valves, so called from their half-moon shape. Each consists of three little pocket-shaped folds of membrane, with their openings in the direction which the blood is to take. When it sets back, they fill, and, swelling out, close the passage (Fig. 32).

The Arteries are the tube-like canals which convey the blood *from* the heart. They are composed of an elastic tissue, which yields at every throb of the heart, and then slowly contracts again, keeping the blood in motion during the expansion of the heart. The elasticity of the arteries acts like the air-chamber of a fire-engine, which converts the intermittent jerks of the brakes or pump into the steady stream of the hose-nozzle.

The Pulse.—At the wrist (radial artery) and on the temple (temporal artery) we can feel the expansion of the artery by each little wave of blood set in motion by the contraction of the heart. In health, there are about seventy-two pulsations per minute. They increase with excitement or inflammation, weaken with loss of vigor, and are modified by nearly every disease. The physician, therefore, finds the pulse a good index of the state of the system and the character of the disorder.

The Veins are the tube-like canals which convey the blood *to* the heart. As they do not receive the direct impulse of the heart, their walls are much thinner and less elastic than those of the arteries. At first small, they increase in size and diminish in number as they gradually pour into one another, like tiny rills collecting to form two rivers, the vena cava ascending and the vena cava descending (Fig. 34), which empty into the right auricle.

Valves similar in construction to those already described are placed at convenient intervals, to guide the blood in its course and prevent its setting backward.

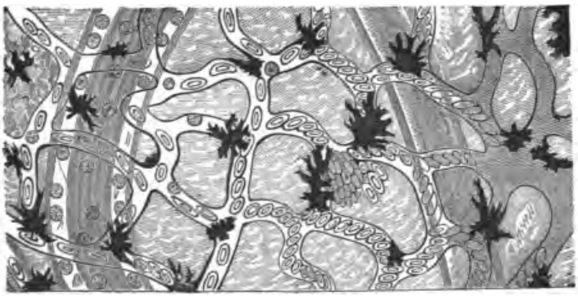
Experiment.—Press your finger on the upper part of one of the blue veins running along your arm toward your hand, and then pass it downward so as to drive the blood backward. Swellings like little knots will appear. Each of these marks the location of a valve, closed by the blood you push before your finger. Remove the pressure, and the valve will open, the blood set forward, and the vein collapse to its former size.

The Capillaries (*capillus*, a hair) form a fine network of tubes, connecting the ends of the arteries with the veins. So closely are they placed, that we

cannot prick the flesh with a needle without injuring, perhaps, hundreds of them. The air-cells of the blood deposit there their oxygen, and receive carbonic acid, while in the delicate capillaries of the lungs they give up their load of carbonic acid in exchange for oxygen.

Experiment.—Stretch, by means of twine and small splints, the transparent web of a living frog's foot, and place it under the microscope. You will see the blood disks winding in single file through the intricate meshes of the capillaries, darting hither and thither, now pausing, swaying to and fro with an uncertain motion, and anon dashing ahead again.

Fig. 33.



A B C

Circulation of the Blood in the Web of a Frog's Foot, highly magnified. A, *an artery;* B, *capillaries crowded with disks, owing to a rupture just above, where the disks are jammed into an adjacent mesh;* C, *a deeper vein; the black spots are pigment cells.*

The Circulation consists of two parts—the *lesser*, and the *greater*.

2. THE LESSER CIRCULATION.—The dark blood from the veins collects in the right auricle, and, going through the tricuspid valve, empties into the right ventricle. Thence it is driven past the semilunar valves, through the pulmonary artery, to the lungs. After circulating through the fine capil-

Fig 34.

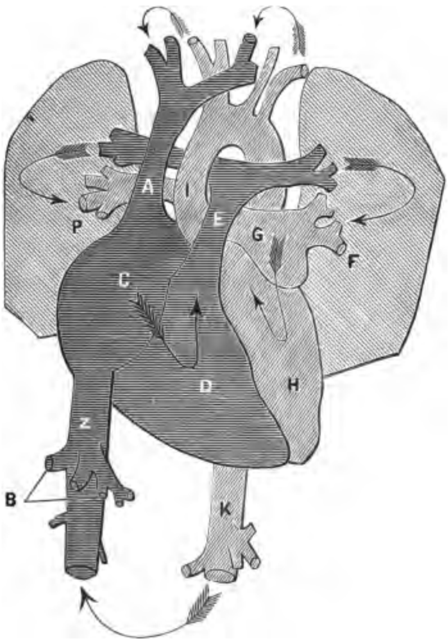


Diagram illustrating the Circulation of the blood. A, *vena cava descending* (*superior*) ; Z, *vena cava ascending* (*inferior*) ; C, *right auricle* ; D, *right ventricle* ; E, *pulmonary artery* ; F P, *lungs and pulmonary veins* ; G, *left auricle* ; H, *left ventricle* ; I, K, *aorta*.—MARSHALL.

laries of the air-cells, it is returned, bright and red, through the four pulmonary veins, to the left auricle.

2. THE GREATER CIRCULATION. — From the left auricle, the blood is forced past the bicuspid valve to the left ventricle ; thence it is driven through the semi-lunar valves into the great aorta, the main trunk of the arterial system. Passing through the arteries, capillaries, and veins, it returns through

the venæ cavæ, ascending and descending (Fig. 34), and gathers again in the right auricle.

Velocity of the Blood.—It has been estimated that a portion of the blood will make the tour of the body in about twenty-three seconds, and that the entire mass passes through the heart in from one to two minutes.

Distribution and Regulation of the Heat of the Body.—1. DISTRIBUTION.—The natural temperature is about 98°. This is kept up by the action of the oxygen within us. Each capillary tube is a tiny stove, where oxygen is combining with the tissues of the body. Every contraction of a muscle develops heat. The warmth so produced is distributed by the circulation of the blood. Thus the arteries, veins, and capillaries form a series of hot-water pipes, through which the heated liquid is forced by a pump—the heart—while the heat is maintained by a multitude of little fires placed here and there along its course.

2. REGULATION.—The temperature of the body is regulated by means of the pores of the skin and those of the mucous membrane in the air-passages. When the system becomes too warm, the blood-vessels on the surface expand, the blood fills them, the fluid leaks into the perspiratory glands, pours out upon the exterior, and by evaporation cools the body.

When the temperature of the body is too low, the vessels contract, less blood goes to the surface, the perspiration decreases, and the loss of heat by evaporation diminishes.

Life by Death.—The body is being incessantly cor-

roded by the tireless oxygen. The scales of the cuticle are constantly falling off and being replaced from the cutis. The disks of the blood die, and new ones spring into being. Every act is a destructive one. Not a bend of the finger, not a wink of the eye, not a thought of the brain but is at some expense of the machine itself. Every process of life is thus a process of death. The more rapidly this change goes on, and fresh, vigorous tissue takes the place of the old, the healthier and stronger we are.

Change of our Bodies.—There is a belief that our bodies change once in seven years. From the nature of the case, the rate must vary with the labor we perform; the organs most used altering oftenest. Probably the parts of the body in incessant employment are reorganized many times in a single year.

Wonders of the Heart.—This marvelous little engine throbs on continually at the rate of 100,000 beats per day, 40,000,000 per year, often 3,000,000,000 without a stop. Its vitality is amazing. Lay upon a table the heart from a freshly-caught sturgeon, all palpitating with life, and it will beat for days as if itself a living creature. The most tireless of organs while life exists, the heart is one of the last to yield when life expires. So long as a flutter lingers there, we know the spark of being is not quite extinguished, and there is hope of restoration. During a long life it will propel half a million tons of blood, yet, with unfaltering labor, repair itself as fast as it wastes, patiently keeping up the play of its valves and the rhythm of its throb till "the wheels of life stand still."

The Lymphatic Circulation.—In nearly every part of the body, mingled with the blood-capillaries, is a second series of capillaries, termed the *Lymphatics.* Most of them converge into the thoracic duct—a small tube, about the size of a goose-quill, emptying into the great veins of the neck (Fig. 35).

Fig. 35.

Lymphatics of the head and neck, showing the glands and, B, *the thoracic duct, as it empties into the left innominate vein at the junction of the left jugular and subclavian veins.*

Along their course, the lymphatics pass through *glands,*—hard, pinkish bodies of all sizes, from that of a hemp-seed to an almond. These glands are often enlarged by disease, and are then easily felt.

THE LYMPH, which circulates through the lymphatics like blood through the veins, is a thin, colorless liquid, very like the serum. This fluid, probably in part an overflow from the blood-vessels, is gathered up by the lymphatics, undergoes in the glands some

process of preparation not well understood, and is then returned to the circulation.

ILLUSTRATIONS.—The poisonous ingredients of most cosmetics and hair-dyes are absorbed by the lymphatics, and so carried into the system. The same result occurs when persons poison their hands with the common wood-ivy. Animals that hibernate are supported during the winter by the fat which their absorbents carry into the circulation from the extra supply they have laid up during the summer. In famine or in sickness, a man unconsciously consumes his own flesh.

Diseases.—1. CONGESTION is an unnatural accumulation of blood in any part of the body. The excess is indicated by the redness. Thus, when we put our feet in hot water, the capillaries expand by the heat, and the blood sets that way to fill them. Blushing is a temporary congestion. The capillaries, being expanded only for an instant by the nervous excitement, contract again and expel the blood.

2. INFLAMMATION means simply a burning. When there is irritation or an injury at any spot, the blood sets thither and reddens it. This extra supply, both by its presence and the friction of the swiftly-moving currents, causes heat. The pressure of the distended vessels upon the nerves frets them, and produces pain. The swelling stretches the walls of the blood-vessels, and the serum or lymph oozes through. The four characteristics of an inflammation are *redness, heat, pain,* and *swelling.*

3. BLEEDING, if from an artery, will be of red blood, and will come in jets; if from the veins, it will be of dark blood, and will flow in a steady stream. If only a small vessel be severed, it may be checked by a piece of cloth held or bound firmly upon the wound. If a large trunk be cut, especially in a limb, make a knot in a handkerchief and tie it loosely about the limb; then, placing the knot on the wound, with a short stick twist the handkerchief tightly enough to stop the flow. If you have a piece of cloth to use as a pad, the knot will be unnecessary. If it be an artery that is cut, the pressure should be applied between the wound and the heart; if a vein, beyond the wound. If you are alone, and are severely wounded,

or in an emergency, like a railroad accident, use the remedy which has saved many a life upon the battle-field,—bind or hold a handful of dry earth upon the wound, elevate the part, and await surgical assistance.

4. SCROFULA is generally inherited. It affects the lymphatic glands, commonly those of the neck, forming "kernels," as they are called. Persons inheriting this disease can ward off its insidious approaches only by the utmost care in diet and exercise; by the use of pure air, and warm clothing; and by avoiding late hours, and all excitants. Insufficient or improper food, and lack of ventilation, rapidly develop the latent seeds of this disease.

5. A COLD.—We change to a thinner dress, or, when heated, sit in a cool place. The skin is chilled, and the perspiration checked. The blood, no longer cleansed and reduced in volume by the drainage through the pores, sets to the lungs for purification. That organ is oppressed, breathing becomes difficult, and the extra mucus secreted by the irritated surface of the membrane is thrown off by coughing. The mucous membrane of the nasal chamber sympathizes with the difficulty, and we have "a cold in the head," or a catarrh. In general, the excess of blood seeks the weakest point, and develops there any latent disease. Thus, a party go out to walk and are caught in a rain; or, coming home from a heated assembly, throw off their coats to enjoy the cool breeze. The next day, one has a fever, another a slight headache, another pleurisy, another pneumonia, another rheumatism, while some escape without injury. The last had enough vital force to withstand the disturbance, but the others had weak points, to which the excess of blood has gone, producing congestion. The first necessity is to restore a regular circulation of the blood. Put the feet in hot water and let them become gorged with the blood thus called from the congested organs. Or, go immediately to bed, and with hot drinks and extra clothing open the pores, and induce free perspiration. This calls the blood to the surface, and, by equalizing the circulation, affords relief.

The rule for the prevention and cure of a cold is to *keep the blood upon the surface.*

ALCOHOLIC DRINKS AND NARCOTICS.

I.—ALCOHOL.

How Alcohol is Formed by Fermentation.—When any substance containing sugar, as fruit-juice, is caused to ferment, the elements of hydrogen, carbon, and oxygen, of which the sugar is composed, re-arrange themselves so as to form carbonic acid, alcohol, and certain volatile oils and ethers. The carbonic acid partly evaporates, and partly remains to give life and sparkle to the liquor; the alcohol is the intoxicating principle; while the oils and ethers impart the peculiar flavor. Thus wine is fermented grape-juice, and cider is fermented apple-juice, each having its distinctive fragrance. (For an account of the subject of Fermentation, read *Steele's New Chemistry*, page 192.)

Manufacture of Beer.—The barley used for making beer is first *malted*, i.e., sprouted, to turn a part of its starch into sugar. When this process has gone far enough, it is checked by heating the grain in a kiln until the germ is destroyed. The malt is then crushed, steeped, and fermented with hops and yeast. The sugar gradually disappears, alcohol is formed, and carbonic acid escapes into the air. The beer is then put into casks, where it undergoes a second, slower fermentation, the flavor ripens, and the carbonic acid gathers; when the liquor is drawn, this gas bubbles to the surface, giving to the beer its sparkling, foamy look.

Spirits.—Alcohol is so volatile that, by the application of heat, it can be driven off as a vapor from

Fig. 36.

Process of Distillation.

the fermented liquid in which it has been produced. Steam and various fragrant substances will pass over with it, and, if they are collected and condensed in a cool receiver, a new and stronger liquid will be formed, having a distinctive odor.

In this way, the alcohol of commerce is distilled from whisky; brandy, from wine; rum, from fermented molasses; whisky, from fermented corn, barley or potatoes; and gin, from fermented barley and rye, afterward distilled with juniper berries. In all liquors, the base is alcohol. It comprises from 3 to 8 per cent. of ale and porter, 7 to 17 per cent. of wine, and 40 to 50 per cent. of brandy and whisky. They may therefore be considered as alcohol more or less diluted with water, and flavored with various

aromatics. In taste, the different liquors—as brandy, gin, beer, cider, etc.,—vary greatly, but they all produce certain physiological effects due to their common ingredient—alcohol.

The Properties of Alcohol may be illustrated in the following very simple manner:

Experiments.—1. Pour a little alcohol into a saucer and apply an ignited match. The liquid will suddenly take fire, burning with intense heat, but feeble light. In this process, alcohol takes up oxygen from the air, forming carbonic-acid gas, and water. 2. Hold a red-hot coil of platinum wire in a goblet containing a few drops of alcohol, and a peculiar odor will be noticed. It denotes the formation of *aldehyde*—a substance produced in the slow oxidation of alcohol. Still further oxidized, the alcohol would be changed into *acetic acid*—the sour principle of vinegar.

One of the most noticeable properties of alcohol is its affinity for water. When strong alcohol is exposed to the air, it absorbs moisture and becomes diluted; at the same time, the spirit itself evaporates. The commercial or proof-spirit is about one-half water; the strongest holds ten per cent.; and, to obtain absolute or waterless alcohol, requires careful distillation in connection with some substance, as lime, that has a still greater affinity for water, and so can despoil the alcohol.

Experiment.—Put the white of an egg—nearly pure albumen—into a cup, and pour upon it some alcohol, or even strong brandy; the fluid albumen will coagulate, becoming hard and solid.

Effect of Alcohol on the Circulation. — During the experiment described on page 74, the influence of alcohol upon the blood may be very easily tested. Place on the web of the frog's foot a drop of dilute spirit. The blood-vessels immediately expand.

Channels before unseen open, and the blood-disks fly along at a brisker rate. Next, touch the membrane with a drop of strong spirit. The blood channels quickly contract; the cells slacken their speed; and, finally, all motion ceases. The flesh shrivels up and dies. The circulation thus stopped is stopped forever. The part affected will in time slough off. Alcohol has killed it.

The influence of alcohol upon the human system is similar. Diluted, as in wine or whisky, it dilates the blood-vessels, quickens the circulation, hastens the heart-throbs, and accelerates the respiration. When strong, it acts as a poison. Persons have drunk a quantity of liquor on a wager, and have paid for their folly with their life. The whole of the blood in the heart being turned into a clot, the circulation ceased, and death was instantaneous.

Effect of Alcohol upon the Heart.—What means this rapid flow of the blood? It shows that the heart is overworking. The nerves that lead to the minute capillaries and regulate the passage of the vital current through the extreme parts of the body, are paralyzed by this active narcotic. The tiny blood-vessels at once expand. This enlargement removes the resistance to the passage of the blood, and hence to the beat of the heart, and the heart flies like the main spring of a clock when the wheels are taken out.

Careful experiments show that two ounces of alcohol—an amount contained in the daily potations of a very moderate ale or whisky drinker—increase the heart-beats 6000 in twenty-four hours; a degree of

work represented by that of lifting a weight of seven tons to a height of one foot. Reducing this sum to ounces and dividing, we find that the heart is driven to do extra work equivalent to lifting seven ounces one foot high 1493 times each hour!

No wonder that the drinker feels a reaction, a physical languor, after the earliest effects of his indulgence have passed away. The heart flags, the brain and the muscles are exhausted, and rest and sleep are imperatively demanded. During this time of excitement, the machinery of life has really been "running down." "It is hard work to fight against alcohol; harder than rowing, walking, wrestling, coal-heaving, or the tread-mill itself."

The pupil should be careful to note here that alcohol does not act upon the heart directly, and cause it to contract with more force. The idea that alcohol gives energy and activity to the muscles is entirely false. It really, as we shall see hereafter, weakens muscular contraction. The enfeeblement begins in the first stage, and continues in the other stages with increased effect. The heart beats quickly merely because the resistance of the minute controlling vessels is taken off, and it works without being under proper regulation. *What is called a stimulation or excitement is, in absolute fact, a relaxation, a partial paralysis* of one of the most important mechanisms in the animal body. Alcohol should be ranked among the narcotics.—(*Richardson*).

Long-continued use of alcohol causes a "degeneration" of the muscular fiber of the heart, so that this organ loses its old power to drive the blood, and, after a time, fails to respond even to the spur that has urged it to ruin.

THIS "DEGENERATION" of the various tissues of the body, we shall find, as we proceed, is a marked effect of alcoholized blood. The change con-

sists in an excess of liquid, or, more commonly, in a deposit of fat. This fatty matter is not an increase of the organ, but it takes the place of a part of its fiber, thus weakening the structure, and reducing the power of the tissue to perform its regular work. Almost everywhere in the body we thus find cells—muscle-cells, liver-cells, nerve-cells, as the case may be—changing, one by one, under the influence of this potent disorganizer, into unhealthy fat-cells. Alcohol has well been termed, "The Genius of Degeneration."

The cause of this degeneration can be easily explained. The increased activity of the circulation compels a correspondingly-increased activity of the cell-changes: but the essential condition of healthful change—the presence of additional oxygen—is wanting, and the operation is imperfectly performed.

Influence upon the Membranes.—The flush of the face and the blood-shot eye, that are such noticeable effects of even a small quantity of liquor, indicate the condition of all the internal organs. The delicate linings of the stomach, heart, brain, liver, and lungs, are reddened, and every tiny vein is inflamed, like the blushing nose itself. When the use of liquor is habitual, the congestion, which at first passes slowly away after each indulgence, becomes permanent, and the discolored blotched skin reveals the state of the entire mucous membrane.

We learned on page 39 what a peculiar office the membrane fills in nourishing the organs it enwraps. Anything that disturbs its delicate structure must mar its efficiency. Alcohol has a wonderful affinity for water. To satisfy this greed, it will absorb moisture from the tissues with which it comes in contact, as well as from their lubricating juices.

The enlargement and permanent congestion of the blood-vessels must interfere with the filtering action

of the membrane. In time, all the membranes become dry, thickened, and hardened; they then shrink upon the sensitive nerve, or stiffen the joint, or enfeeble the muscle. The function of these membranes being deranged, they will not furnish the organs with perfected material, and the clogged pores will no longer filter their natural fluids. Every organ in the body will feel this change.

Effect upon the Blood.—From the stomach, alcohol passes directly into the circulation, and so, in a few minutes, is swept through the entire system. If it be present in sufficient amount and strength, its eager desire for water will lead it to absorb moisture from the red disks, causing them to shrink, change their form, harden, and lose some of their ability to carry oxygen; it may even make them adhere in masses, and so hinder their passage through the tiny capillaries.—(*Richardson*).

The avidity of alcohol for water causes a burning thirst, familiar to all drinkers, and hence the use of enormous quantities of liquor, generally beer. This dilutes the blood, which then easily flows from a wound, and, as it does not coagulate like healthy blood, renders an accident or surgical operation dangerous.

Sometimes, on the contrary, when spirits are used in excess, the blood tends to coagulate in the capillaries. There is then the liability of an obstruction to the flow of the vital current through the heart, liver, lungs, etc., that may cause disease, and in the brain may lay the foundation of paralysis or apoplexy.

Wherever the alcoholized blood goes through the body, it bathes the delicate cells with an irritating, narcotic poison, instead of a bland, nutritious substance.

Effect upon the Lungs.—Here we can see how certainly the presence of alcohol interferes with the red disks in their task of carrying oxygen. "Even so small a quantity as one part of alcohol to 500 of the blood will materially check the absorption of oxygen in the lungs."

The cells, unable to take up oxygen, retain their carbonic-acid gas, and so return from the lungs, carrying back, to poison the system, the refuse matter the body has sought to throw off. Thus the lungs no longer furnish properly-oxygenized blood.

The rapid stroke of the heart, already spoken of, is followed by a corresponding quickening of the respiration. The flush of the cheek is repeated in the reddened mucous membrane lining the lungs.

When this enlargement of the capillaries becomes permanent, and the highly-albuminous membrane of the air-cells is hardened and thickened as well as congested, the passage of the gases to and fro through its pores can no longer be prompt and free as before. Even when the effect passes off in a few days after the occasional indulgence, there is, during that time, a diminished supply of the life-giving oxygen furnished to the system; weakness follows, and, in the case of hard drinkers, there is a marked liability to epidemics.

A volume of statistics could be filled with quotations like the following: "Mr. Huber, who saw in one town in Russia two thousand one hundred

and sixty persons perish with the cholera in twenty days, said: 'It is a most remarkable circumstance that persons given to drink have been swept away like flies. In Tiflis, with twenty thousand inhabitants, every drunkard has fallen,—all are dead, not one remaining.'"

Physicians tell us, also, that there is a peculiar form of consumption caused by long-continued and excessive use of liquor. It generally attacks those whose splendid constitution has enabled them to "drink deep" with apparent impunity. This type of consumption appears late in life and is considered incurable.

PRACTICAL QUESTIONS.

1. Why does a dry, cold atmosphere favorably affect catarrh?
2. Why should we put on extra covering when we lie down to sleep?
3. Is it well to throw off our coats or shawls when we come in heated from a long walk?
4. Why are close-fitting collars or neck-ties injurious?
5. Which side of the heart is the more liable to inflammation?
6. When a fowl is angry, why does its comb redden?
7. Why does a fat man endure cold better than a lean one?
8. Why does one become thin during a long sickness?
9. What would you do if you should come home "wet to the skin"?
10. When the cold air strikes the face, why does it first blanch and then flush?
11. By what process is alcohol always formed? Does it exist in nature?
12. What per-centage of alcohol is contained in the different kinds of liquor?
13. What is the common intoxicating principle of whisky and brandy, as of beer and cider?
14. Describe the general properties of alcohol.
15. Show that alcohol is a narcotic poison.
16. If alcohol is not a stimulant, how does it cause the heart to overwork?

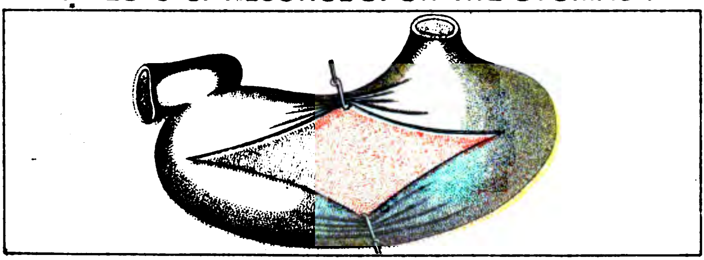
17. Why is the skin of a drunkard always red, and blotched?
18. What must be the effect of tight lacing upon the circulation?
19. Why does a hot foot-bath relieve the headache?

BLACKBOARD ANALYSIS.

THE CIRCULATION.

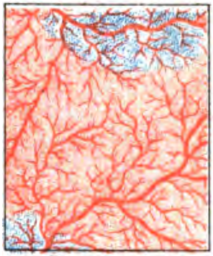
- 1. THE BLOOD.
  - 1. Its Composition.
  - 2. Its Uses.
  - 3. Coagulation.
- 2. ORGANS OF THE CIRCULATION.
  - 1. The Heart.
    - 1. Description.
    - 2. Movements.
    - 3. Auricles and Ventricles.
    - 4. The Valves.
      - a. Need of.
      - b. Tricuspid and Bicuspid.
      - c. Semi-lunar Valves.
  - 2. The Arteries
    - 1. Description.
    - 2. The Pulse.
  - 3. The Veins.
    - 1. General Description.
    - 2. Valves.
  - 4. The Capillaries.
    - 1. Description.
    - 2. Use.
    - 3. Under the Microscope.
- 3. THE CIRCULATION.
  - 1. The Lesser.
  - 2. The Greater.
  - 3. The Velocity of the Blood.
- 4. THE HEAT OF THE BODY.
  - 1. Distribution.
  - 2. Regulation.
- 5. LIFE BY DEATH.
- 6. CHANGE OF OUR BODIES.
- 7. WONDERS OF THE HEART.
- 8. THE LYMPHATIC CIRCULATION.
  - 1. Description.
  - 2. The Glands.
  - 3. The Lymph.
  - 4. Illustrations.
- 9. DISEASES.
  - 1. Congestion.
  - 2. Inflammation.
  - 3. Bleeding.
  - 4. Scrofula.
  - 5. A Cold.
- 10. ALCOHOLIC DRINKS AND NARCOTICS.
  - 1. How Alcohol is formed.
  - 2. Manufacture of Beer.
  - 3. Spirits.
  - 4. Properties of Alcohol.
  - 5. Effect of Alcohol upon the Circulation.
  - 6. " " " Heart.
  - 7. " " to cause fatty degeneration.
  - 8. " " upon the Membrane.
  - 9. " " " Blood.
  - 10. " " " Lungs.

EFFECTS OF ALCOHOL UPON THE STOMACH.



Healthful.

Moderate Drinking.

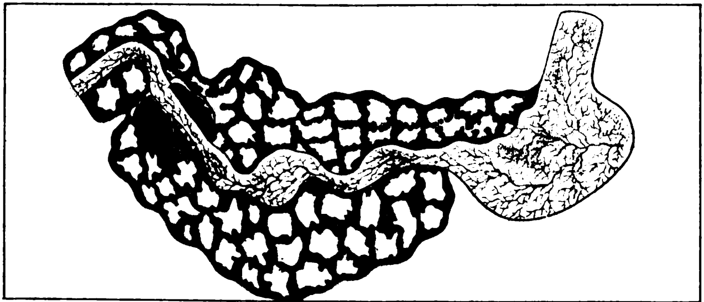


Drunkards.

Ulcerous.

After a long Debauch

Death by Delirium Tremens.



The Cancerous Stomach.

DIGESTION AND FOOD.

WHY **we need Food.**—We have learned that our bodies are constantly giving off waste matter—the products of the fire, or oxidation, as the chemist terms it, going on within us. A man without food will starve to death in a few days, i. e., the oxygen will consume his available flesh. To replace the daily outgo, we need about two and a quarter pounds of food, and three pints of drink.

Including the eight hundred pounds of oxygen taken from the air, a man uses in a year about a ton and a half of material. Yet during this entire time his weight may be nearly uniform.

Our bodies, says Huxley, may be likened to an eddy in the river, which retains its shape for a while, though every instant each particle of water is changing.

What Food Does.—We make no force ourselves. We can use only what nature provides. All our strength comes from the food we eat. Food is force—that is, it contains a power which it gives up to us when it becomes our flesh. Oxygen is the magic key which unlocks for our use this hidden store. Putting food into our bodies is like placing a wound-up spring in a watch; every motion of the body is

dependent upon the food-force just as every movement of the hand on the watch-dial represents the power of the spring.

Every cell in the tissues is full of matter ready to set free at call its stored-up energy—derived from the meat, bread, and vegetables we have eaten. This energy will pass off quietly when the organs are in comparative rest, but violently when the muscles contract with force. When we send an order through a nerve to any part of the body, a series of tiny explosions run the entire length of the nerve, just as fire runs through a train of gunpowder. The muscle receives the stimulus, and, contracting, liberates its energy. The cells of nerve or muscle, whose contents have thus exploded, as it were, are useless, and must be carried off by the blood, just as ashes must be swept from the hearth, and new fuel be supplied to keep up a fire.

Kinds of Food Needed.—In order to produce heat and force, we need something that will burn, i. e., with which oxygen can combine. To keep the body in the best condition, we require three kinds of food.

1. FOOD CONTAINING NITROGEN.—This is needed for the growth and repair of the muscles, which so readily oxidize and provide us with force. Cheese, lean meat, and the whites of eggs are examples of nitrogenous, or, as it is generally called, albuminous food.

2. FOOD CONTAINING CARBON.—This comprises the *sugars* and the *fats*. In digestion, starch (which is abundant in potatoes, corn, etc.) is changed to sugar, and hence is ranked with this class of food.

Experiment.—Take a slice of raw potato, and let fall on it a few drops of very weak tincture of iodine—found at any drug-store. Iodine turns starch blue. Note the effect on the potato, which shows the starch it contains.

3. Food Containing Mineral Matter. — Our bodies need water, iron, sulphur, magnesia, phosphorus, salt, potash, etc.

About three pints of water are required daily to dissolve our food and carry it through the circulation, to float off waste matter, to lubricate the tissues, and to cool the system. Water also composes a large share of the body. A man weighing 154 pounds contains 100 pounds of water, about 12 gallons,—enough, if rightly arranged, to drown him.

Iron goes to the blood disks; lime helps to give solidity to the bones and teeth; phosphorus is essential to the activity of the brain. Salt assists in digestion, and also aids in working off waste products from the system.

One Kind of Food is Insufficient.—A person fed only on sugar, for example, would die. It would be a clear case of nitrogen starvation. He might live some time on nitrogenous food alone, as that contains carbon, the elements of water, and some mineral matter. But it would take such an enormous quantity of food — lean meat, for instance — to supply the carbon, that his poor stomach would at last be sure to give up in despair.

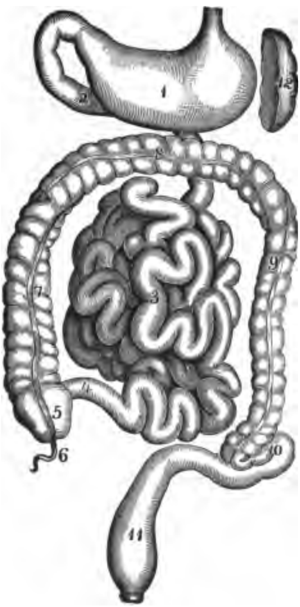
The need of a mixed diet is shown in the fact that instinct everywhere suggests it. Butter is used with bread; oil is relished with salad; milk is boiled with rice; cheese is eaten with maccaroni, and pork is baked with beans.

Object of Digestion.—If food were cast directly into the blood, it could not be used. For example, although the chemist cannot see wherein the albu-

men of the egg differs from the albumen of the blood, yet if it be injected into the veins it will not serve the purposes required, and is thrown out again. Digestion fits the food for use in the body.

General Plan of Digestion.—Nature has provided for this purpose an entire laboratory, furnished with a chemist's outfit of knives, mortars, baths, chemicals, filters, etc. The food is (1) chewed, mixed with the saliva in the mouth, and swallowed; (2) acted upon by the gastric juice in the stomach; (3) passed into the intestines, where it receives the bile, pancreatic juice, and other liquids which dissolve it; (4) the nourishing part is absorbed in the stomach and intestines, and thence thrown into the blood-vessels, whence it is whirled through the body by the circulation. These processes take place within the *alimentary canal*, a narrow, winding tube which begins at the mouth, and is about thirty feet long.

Fig. 37.



The Stomach and Intestines. 1, *stomach*; 2, *duodenum*; 3, *small intestine*; 4, *termination of the ileum*; 5, *cæcum*; 6, *vermiform appendix*; 7, *ascending colon*; 8, *transverse colon*; 9, *descending colon*; 10, *sigmoid flexure of the colon*; 11, *rectum*; 12, *spleen — a gland whose action is not understood.*

I. Mastication.—1. THE SALIVA.—The food while being cut and ground by the teeth is mixed with

2/3 of body.

Fig. 38.

The Parotid—one of the three salivary glands that open into the mouth by ducts.

the saliva. This is a colorless, frothy, alkaline liquid, secreted (*i. e.*, separated from the blood), by the mucous membrane lining the mouth, and by the salivary glands. The amount, on the average, is about three pounds per day, and in health is sufficient to keep the mouth moist. The saliva changes the starch of our food into sugar, and, by softening and dissolving what we eat, enables us to get the different flavors.

2. The Process of Swallowing.—The food, thus pulverized, softened, and lubricated by the saliva, is conveyed by the tongue and cheek to the back of the mouth. The soft palate lifts to close the nasal opening; the epiglottis shuts down, and along this bridge the food is borne, without danger of falling into the windpipe or escaping into the nose. The muscular bands of the throat now seize it and take it beyond our control. The fibers of the œsophagus contract above, while they are lax below, and convey the food by a worm-like motion into the stomach.

Experiment.—Observe the peculiar motion of the œsophagus by watching a horse's neck when he is drinking.

II. Gastric Digestion.—1. The Stomach is shaped very like a Scotch bag-pipe, and holds about three

pints. It is composed of three coats, or layers: (1), an inner, soft, mucous membrane, which secretes the digestive fluids; (2), an outer, strong, smooth coat which prevents friction and gives support; and (3), between them, a stout muscular layer composed of fibers, some lying lengthwise, some obliquely, and some passing round the stomach. When these fibers contract, they produce a peculiar churning motion which thoroughly mixes the contents of the stomach. At the further end, the muscular fibers form a gateway (*pylorus*, a gate), which carefully guards the exit, to prevent food from passing out of the stomach until properly prepared.

2. THE GASTRIC JUICE.—The inner lining of the stomach is soft, velvety, and of a pinkish hue; but, as soon as food is admitted, the blood-vessels fill, and the surface becomes a bright red. Soon there exudes a thin, colorless, acid fluid—the gastric juice. About twelve pounds of this are daily secreted. Its flow is checked by cold water, and may be stopped by anger, fatigue, or anxiety.

The chief value of the gastric juice consists in a peculiar substance called *pepsin*, which causes the albuminous food to dissolve, but has no effect on the fats or the sugars.

The food, reduced by the gastric juice to a grayish, soupy mass, called *chyme* (kīme), escapes through that jealously-guarded door, the pylorus.

III. Intestinal Digestion.—The structure of the intestines is like that of the stomach. There is the same outer, smooth membrane to prevent friction, the lining of mucous membrane to secrete the diges-

Fig. 39.

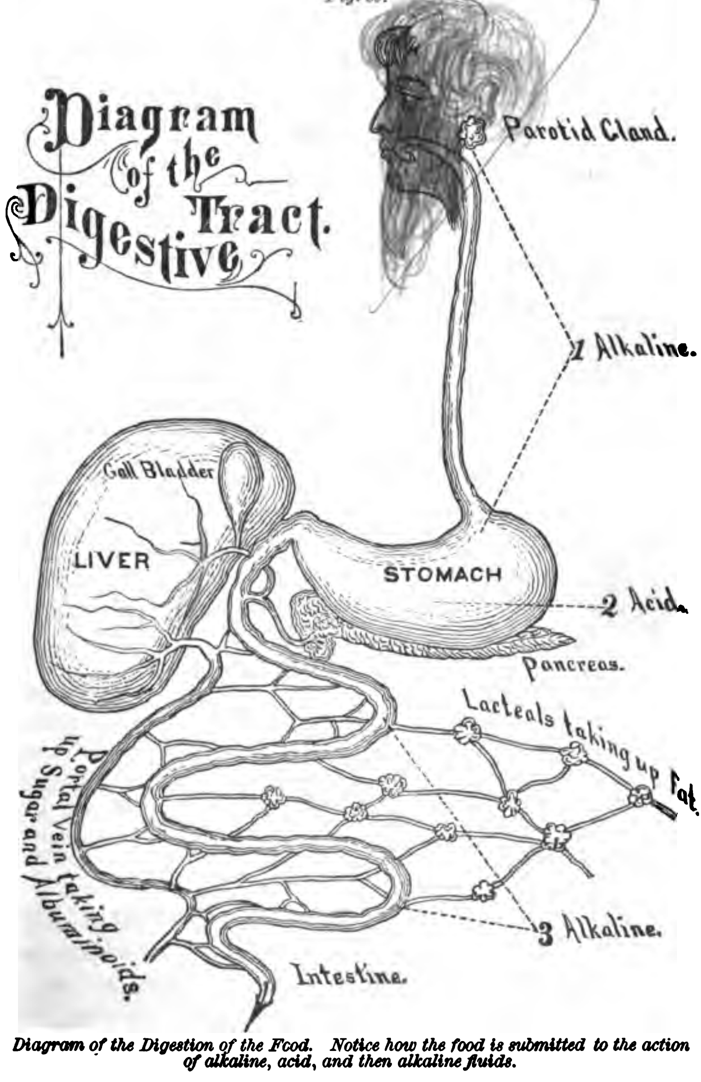
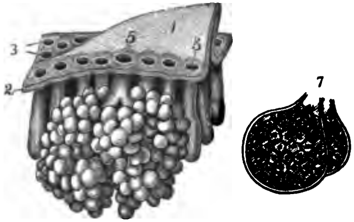


Diagram of the Digestion of the Food. Notice how the food is submitted to the action of alkaline, acid, and then alkaline fluids.

tive fluids, and the muscular coating to push the food forward.

The intestines are divided into the *small*, and the *large*. The first part of the former opens out of the stomach, and is called the *du-o-de'-num*, as its length is equal to the breadth of twelve fingers. Here the chyme is acted upon by the *bile*, and the *pancreatic juice*.

Fig. 40.



A vertical Section of the Duodenum, highly magnified. 1, a fold-like villus; 2, epithelium, or cuticle; 3, orifices of intestinal glands; 5, orifice of duodenal glands; 7, more highly magnified sections of the cells of a duodenal gland.

1. THE BILE is secreted by the liver, which is the largest gland in the body, and weighs about four pounds. It is located on the right side, below the diaphragm. The bile is of a dark, golden color, and bitter taste. About three pounds are daily secreted. When not needed for digestion, it is stored in the gall cyst.

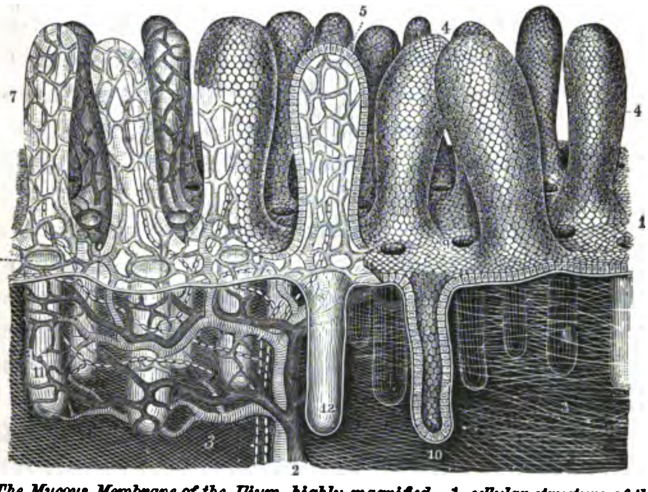
In the tiny liver-cells (each one smaller than a fine pin's head), sugar is changed into a kind of insoluble starch called *glycogen*. This is stored up in the liver and muscles until needed elsewhere, when it is once more converted into soluble sugar and taken up by the circulation. The liver also changes the waste and surplus albuminous matter into bile, and into urea and uric acid—the forms in which nitrogenized waste is excreted by the kidneys.

2. THE PANCREATIC JUICE is a secretion of the pancreas, or sweet-bread—a gland nearly as large as the hand, lying behind the stomach. This alkaline juice, which has also the power of changing starch to sugar, breaks the globules of fat into minute par-

ticles, that mix freely with water, and remain suspended in it like butter in milk. The whole mass now has a milky look, whence it is termed *chyle* (kīle), and passes on to the small intestine.

3. THE SMALL INTESTINE is an intricately-folded tube, about twenty feet long, and from an inch to an inch and one-half in diameter. As the chyle

Fig. 41.



The Mucous Membrane of the Ilium, highly magnified. 1, *cellular structure of the epithelium, or outer layer*; 2, *a vein*; 3, *fibrous layer*; 4, *villi covered with epithelium*; 5, *a villus in section, showing its lining of epithelium, with its blood-vessels and lymphatics*; 6, *a villus partially uncovered*; 7, *a villus stripped of its epithelium*; 8, *lymphatics, or lacteals*; 9, *orifices of the glands opening between the villi*; 10, 11, 12, *glands*; 13, *capillaries surrounding the orifices of the gland.*

passes through this winding channel, it receives secretions which combine the action of all the previous ones, and affect equally the starch, fat, and albumen.

IV. Absorption is performed by the *veins*, and the

lacteals. (1.) The Veins in the stomach immediately begin to take up the water, salt, and other substances that need no special preparation. In the small intestine, there is a multitude of tiny projections (*villi*) from the folds of the mucous membrane, more than 7000 to the square inch, giving it a soft, velvety look. These little rootlets, reaching out into the milky fluid, drink into their minute blood-vessels the nutritious part of every sort of food.

(2.) The Lacteals, a set of vessels starting in the villi side by side with the veins, absorb the principal part of the fat. They convey the chyle through the lymphatics and the thoracic duct (Fig. 35) to the veins, and so within the sweep of the circulation.

The Portal Vein carries to the liver the food absorbed by the veins of the stomach and the villi of the intestines. In the cells of the liver, it undergoes as mysterious a process as that performed by the lymphatic glands, and is then cast into the circulation.

The Length of Time Required for digesting a full meal is from two to four hours. It varies with the kind of food, state of the system, thoroughness of mastication, etc.

In 1822, Alexis St. Martin, a Canadian in the employ of the American Fur Company, was accidentally shot in the left side. Two years after, the wound was entirely healed, leaving, however, an opening about two and a half inches in circumference into the stomach. Through this the mucous membrane protruded, forming a kind of valve which prevented the discharge of food, but could be readily depressed by the finger, thus exposing the interior. For several years he was under the care of Dr. Beaumont, a

skillful physician, who experimented upon him by giving him various kinds of food, and watching their digestion through this opening. His stomach was found empty in two and a half hours after a meal of roast turkey, potatoes, and bread. Pigs' feet and boiled rice were disposed of in an hour. Fresh, sweet apples took one and a half hours; boiled milk, two hours; and unboiled, a quarter of an hour longer. In eggs, which occupied the same time, the case was reversed,—raw ones being digested sooner than cooked. Roast beef and mutton required three, and three and a quarter hours respectively; veal, salt beef, and broiled chicken remained for four hours; and roast pork enjoyed the bad pre-eminence of needing five and a quarter hours.

Value of Different Kinds of Food.—BEEF and MUTTON possess the greatest nutritive value of any meats. LAMB is less strengthening, but more delicate. PORK has much carbon. It sometimes contains a parasite called trichina, which passes into the human system, producing disease and often death; the only safety is in thorough cooking. FISH is more watery than flesh, and many find it difficult of digestion. Like meat, it loses its mineral properties and natural juices when salted, and becomes less nourishing. Oysters are highly nutritious, but are more easily digested raw than cooked. MILK is a model food, as it contains albumen, starch, fat, and mineral matter. No single substance can sustain life for so long a time. CHEESE is very nourishing—one pound being equal in value to two of meat, but it is not adapted to a weak stomach. EGGS are most easily digested when the white is barely coagulated, and the yolk is unchanged. BREAD should be made of unbolted flour. The bran of wheat furnishes the mineral matter we need in our bones and teeth, gives the bulk so essential to the proper distension of the

digestive organs, and by its roughness gently stimulates them to action. Very fresh bread, warm biscuit, etc., are condensed by mastication into a pasty mass that is not easily penetrated by the gastric juice, and hence they are unwholesome. CORN is rich in fat. It contains, however, more indigestible matter than any other grain, except oats, and is less nutritious than wheat. The POTATO is two-thirds water,—the rest being mainly starch. RIPE FRUITS, and those vegetables usually eaten raw, dilute the food, and supply the blood with cooling acids.

The Stimulants.—COFFEE is about half nitrogen, and the rest fatty, saccharine, and mineral substances. It is, therefore, of much nutritive value, especially when taken with milk and sugar. Its stimulating property is due to a substance called *caffeine*. Its aroma is developed by browning, but destroyed by burning.

No other drink so soon relieves fatigue. Taken in moderation, it clears the intellect, tranquillizes the nerves, and usually leaves no unpleasant reaction. In some cases, however, it produces a rush of blood to the head, and should be at once discarded. At the close of a full meal it hinders digestion, and at night produces wakefulness.

TEA possesses an active principle called *theine*, and also contains tannin, which, if the tea is strong, coagulates the albumen of the food—*tans* it—and thus delays digestion.

Experiment.—Let a drop of strong tea fall on a steel knife-blade. The black spot produced is a tannate of iron,—a compound of the tannic acid in the tea and the metal.

When used moderately, the effect of tea resembles that of coffee; in excess, it causes nervous tremor, disturbed sleep, palpitation of the heart, and indigestion. In youth, when the vital powers are strong and nature promptly rallies from fatigue, these stimulants are needless, and often positively injurious.

The Cooking of Food breaks the little cells and softens the fibers of which it is composed. In broiling or roasting, meat should be exposed to a strong heat at once, in order to coagulate the albumen upon the outside, and thus prevent the escape of the nutritious juices. The cooking may then be finished at a lower temperature. The same principle applies to boiling meat. In making soups, on the contrary, the heat should be applied slowly, and should reach the boiling point only for a few moments at the close. This prevents the coagulation of the albumen. Frying is an unwholesome mode of cooking food, as it disorganizes the fat.

Rapid Eating produces many evil results. 1. There is not enough saliva mixed with the food; 2. The coarse pieces resist the action of the digestive fluids; 3. The food is washed down with drinks that dilute the gastric juice, and hinder its work; 4. We do not realize how much we eat until the stomach is overloaded; 5. Failing to get the taste of our food, we think it insipid, and hence use condiments that fret the digestive organs. In these various ways, the stomach is over-worked, and the foundation of dyspepsia laid.

The Quantity and Quality of Food required vary

with age and habits. The diet of a child should be largely vegetable, and more abundant than that of an aged person. An inactive life calls for less food than an active one. When a boy accustomed to out-door work enters school, he should practice self-denial until his system becomes fitted to the new order of things. He should not, however, fall into the opposite error, and starve himself.

The season, also, should modify the diet. In winter, we need highly carbonaceous food—plenty of fat meat, etc.; but in summer we should temper the heat in our ~~corporeal~~ stoves with fruits and vegetables.

The climate, too, has its necessities. The inhabitants of the frigid north have an almost insatiable longing for fat. Thus, in 1812, when the Allies entered Paris, the Cossacks drank all the oil from the lamps, and left the streets in darkness. In tropical regions, Nature furnishes the proper diet of fruits.

When Food should be Taken.—On taking food, the blood sets at once to the alimentary canal, and the energies become fixed upon digestion. We should not, therefore, undertake hard study, labor, or exercise, directly after a hearty meal. He who toils with brain or muscle, and thus centers the blood in any particular organ, before eating should allow time for the circulation to become equalized. There should be an interval of four to five hours between our regular meals, and there should be no lunching between times. With young children, where the vital processes are more rapid, less time

may intervene. Nothing should be eaten within two or three hours of retiring.

How Food should be Taken.—A good laugh is the best of sauces. The meal-time should be the happiest hour of the day. Care and grief are the bitterest foes of digestion. A cheerful face and a light heart are friends to long life, and nowhere do they serve us better than at the table.

Need of a Variety.—Experiments show that no one article of food, however nutritious, will keep up the highest working-power of the body. Nature demands change, and she furnishes the means to gratify it. We should avoid, however, the other extreme, and not, by too great variety, over-tempt the appetite.

The Wonders of Digestion.—We can understand much of the process of digestion. We can look into the stomach and trace its various steps. Indeed, the chemist can reproduce in his laboratory many of the operations; "a step further," as Fontenelle has said, "and he would surprise nature in the very act." Just here, when he seems so successful, he is compelled to pause. The secret of the cell—Nature's tiny laboratory—eludes his search.

How strange is this change of food to flesh! We make a meal of meat, vegetables, and drink. Ground by the teeth, mixed by the stomach, and dissolved by the digestive fluids, it is swept through the body. Each organ, as it passes, snatches its particular food, which, within the cells of its tissues, it transforms into the soft, sensitive brain, or the hard, callous bone; into briny tears, or bland saliva,

or acrid perspiration; into bile for digestion, oil for the hair, nails for the fingers, or flesh for the cheek.

Diseases.—1. DYSPEPSIA, or indigestion of food, is generally caused by over-taxing the digestive organs. We tempt ourselves with luscious flavors and a great variety of dishes, till we overload the stomach and burden the entire system. We take meals at irregular hours, when the fluids are not ready. We force a hearty supper upon the body when, wearied with the day's labor, it demands repose. We devote the shortest possible time to meals, and thrust upon our stomachs unmasticated lumps of food, washing them down with floods of ice-cold water or scalding tea. Nature having taken away our appetite in order to rest our weak digestion, we forthwith excite it by stimulants and narcotics, and still further oppress the suffering organs. Strong tea, alcoholic drinks, hot bread, rich pastry, biscuit and cake yellow with soda or saleratus, meat fried till the fat is disorganized and the fiber hardened,—all these derange the action of the alimentary canal. The patient, abused stomach struggles on, perhaps for years, through discomfort, pain, and the accumulating agonies of indigestion, till finally the last penalty of violated law is paid, and the confirmed dyspeptic finds relief in death.

2. THE MUMPS are a swelling of the parotid gland (one of the salivary glands, Fig. 37). The disease is generally epidemic, and the patient should be carefully secluded for the sake of others as well as himself. The swelling may be allowed to take its course. Relief from pain is often obtained by applying flannels wrung out of hot water. Great care should be used not to check the inflammation, and, on first going out after recovery, not to take cold.

ALCOHOLIC DRINKS AND NARCOTICS.

I. ALCOHOL (Continued from p. 89).

Relation of Alcohol to the Digestive Organs.—*Is Alcohol a Food?* To answer this question, let us make a comparison. If you receive into your

stomach a piece of bread or beef, Nature welcomes its presence. The juices of the system at once take hold of it, dissolve it, and transform it for the uses of your body. A million tiny fingers (lacteals and veins) reach out to grasp it, work it over, and carry it into the circulation. The blood bears it onward wherever it is needed to mend or to build "The house you live in." Soon, it is no longer bread or beef; it is flesh on your arm; its chemical energy has become your strength.

If, on the other hand, you take alcohol into your stomach, it receives no such welcome. Nature treats it as a poison, and seeks to rid herself of the intruder as soon as possible. The juices of the system flow from every pore to dilute and weaken it, and to prevent its shriveling up the delicate membranes with which it comes in contact. The veins take it up and bear it rapidly through the system. All the scavengers of the body—the lungs, the kidneys, the perspiration-glands—at once set to work to throw off the enemy. So surely is this the case, that the breath of a person who has drunk only a single glass of the lightest beer will betray the fact.

So far as known, the alcohol thus rejected is entirely unchanged. Nature seems to have no use for it, so it courses everywhere through the circulation and into the great organs, with all its properties unaltered.

Alcohol, then, is not, like bread or beef, broken up by the mysterious process of digestion, for the benefit of the body, "It cannot therefore be regarded as a food."—(*Flint.*) "That alcohol is incapable of form-

ing any part of the body, is admitted by all physiologists. It cannot be converted into brain, nerve, muscle, or blood."—(*Cameron.*)

Effect upon the Digestion.—Alcohol precipitates (causes to settle) the pepsin of the gastric juice, and so hinders its work; it also coagulates the albumen of the food, and thus still further obstructs digestion. Anything that interferes with Nature's plan of getting our food ready for our use must be injurious. The experiments of Dr. Munroe, published in the London Medical Journal, and here summarized, show that the tendency to retard digestion is common to alcoholic drinks.

Minced Beef put into	2d Hour.	4th Hour.	6th Hour.	8th Hour.	10th Hour.
I. Gastric juice and *water*.	Beef opaque.	Digesting and separating.	Beef much lessened.	Broken up into shreds.	Dissolved like soup.
II. Gastric juice and *alcohol*.	No alteration perceptible.	Slightly opaque, but beef unchanged.	Slight coating on beef.	No visible change.	Solid on cooling. *Pepsin* precipitated.
III. Gastric juice and *pale ale*.	No change.	Cloudy, with fur on beef.	Beef partly loosened.	No further change.	No digestion. *Pepsin* precipitated

The greed of alcohol for water causes it to imbibe moisture from the tissues and juices, and to inflame the delicate mucous membrane. It shows how patiently nature adapts herself to circumstances, that the soft, velvety lining of the throat and stomach should come at length to endure the presence of a fiery liquid which, undiluted, would soon shrivel and

destroy it. In self-defence, the juices pour in to weaken the alcohol, and it is soon hurried into the circulation. Before this can be done, "it must absorb about three times its bulk of water;" hence, very strong liquor may be retained in the stomach long enough to interfere seriously with the digestion, and to injure the lining coat. Habitual use of alcohol permanently dilates the blood-vessels; thickens and hardens the membranes; in some cases, ulcerates the surface; and, finally, so weakens the digestion that the proper supply of food cannot be appropriated.—(*Flint.*)

Effect upon the Liver.—Alcohol is carried by the portal vein directly to the liver. This organ, after the brain, holds the largest share. The influence of the poison is here easily traced. "The color of the bile is soon changed from yellow to green, and even black." The connective tissue between the cells becomes inflamed, and matter is sometimes deposited, causing "fatty degeneration," so that the liver is increased to twice its natural size. In the confirmed drunkard, the fibrous tissue shrinks, the cells are closed, the organ becomes smaller, and the surface assumes a peculiar appearance known as the "hob-nailed liver."

Effect upon the Kidneys.—The kidneys, like the liver, are liable to undergo, through the influence of alcohol, a "fatty degeneration," in which the cells, becoming filled with fat, are unable to separate the waste material that comes to them to be thrown off. This poisonous matter, therefore, is returned to the circulation. Worst of all, the membranes may be

so affected as to allow the albuminous part of the blood to filter through them, and thus rob the body of one of its most valuable constituents.

Does Alcohol Impart Heat?—Directly after drinking liquor, a flush is felt. This is caused by the tides of warm blood that are being sent to the surface of the body, in consequence of the enlargement of the capillaries, and the rapid pumping of the heart. No fresh heat is developed. On the contrary, the bringing the blood to the surface causes it to cool faster, and a reaction follows. The inebriate becomes chilly as he sobers, and a delicate thermometer placed under his tongue may show a fall of even two degrees below the standard temperature of the body. Several hours are required to restore the usual heat.

Dr. N. S. Davis, of Chicago, instituted an extensive series of experiments to determine the effect of the different articles of food and drink on the temperature of the system. He proved that, during the digestion of all kinds of food, the temperature of the body is increased, but when alcohol is taken, the temperature begins to fall within a half-hour, and continues to decrease for two or three hours ; and that the reduction of temperature, in extent as well as in duration, is in exact proportion to the amount of alcohol.

We see, therefore, that liquor does not fortify against cold. Dr. Hayes, the Arctic explorer, says : "While fat is absolutely essential to life in Arctic countries, alcohol is positively injurious. I have known strong, able-bodied men to become utterly incapable of resisting cold in consequence of the long-continued use of alcoholic drink."

Does Alcohol Impart Strength?—Experience shows

that alcohol unfits one for severe bodily exertion. Men who are in training for running, rowing, and other contests where great strength is required, deny themselves all liquors, even when ordinarily accustomed to their use.

Dr. Richardson made some interesting experiments to show the influence of alcohol upon muscular contraction. He carefully weighted the hind leg of a frog, and, by means of electricity, stimulating the muscle to its utmost power of contraction, he found out how much the frog could lift. Then administering alcohol, he discovered that the response of the muscles to the electrical current became feebler and feebler, as the narcotic began to take effect, until, at last, the animal could raise less than half the amount it lifted by the natural contraction when uninfluenced by alcohol.

Effect upon the Waste of the Body.—The tendency of alcohol is to check the ordinary waste of the system, so that "the amount of carbonic acid exhaled from the lungs may be reduced as much as 30 to 50 per cent."—(*Hinton.*) We have seen that when the functions are in full play, each organ is being constantly torn down, and as constantly rebuilt with materials furnished from our food. Anything that checks this oxidation of the tissues, or hinders the deposition of new matter, diminishes the vital force. Both these results are the certain effects of alcohol, for, since the blood contains less oxygen and more carbonic acid, and since the power of digesting food is decreased, it follows that every process of waste and repair must be weakened. The person using liquor therefore needs less bread and beef, and so he wrongfully imagines that alcohol is a food.

Alcohol Creates a Progressive Appetite for itself. —When liquor is habitually taken, even in the most moderate quantity, it soon becomes necessary ; and then arises a craving demand for an increased amount to produce the original effect. No food creates this constantly-augmenting want. A cup of milk drunk at dinner does not lead one to go on, day by day, drinking more and more milk, until to get milk becomes the one great longing of the whole being. Yet this is the almost universal effect of alcohol. Hunger is satisfied by any nutritious food : the dram-drinker's thirst demands alcohol. Common observation teaches the peril that attends the formation of such a progressive poison-habit. A single glass taken as a simple tonic may lead to the drunkard's grave.

Worse than this, the alcoholic craving may be transmitted from father to son. Young persons often find themselves cursed with a terrible disease known as alcoholism (dipsomania)—a keen, morbid, overwhelming appetite for liquor stamped upon their very being through the reckless indulgences of some ancestor.

The Law of Heredity is, in this connection, well worth notice. "The world is beginning to perceive," says Francis Galton, "that the life of each individual is, in some real sense, a continuation of the lives of his ancestors." "Each of us is the footing up of a double column of figures that goes back to the first pair." "We are omnibuses," remarks Holmes, "in which all our ancestors ride." We inherit from our parents our features, our physical vigor, our mental faculties, and even much of our moral character. Often, when one generation is skipped, the qualities will reappear in the following one. The virtues, as well as the vices, of our forefathers, have added to, or subtracted from, the strength of our brain and muscle.

The evil tendencies of our natures, which it is the struggle of our lives to resist, constitute a part of our heir-looms from the past. Our descendants, in turn, will have reason to bless us only if we hand down to them a pure and healthy physical, mental, and moral being.

"There is a marked tendency in nature to transmit all diseased conditions. Thus, the children of consumptive parents are apt to be consumptives. But of all agents, alcohol is the most potent in establishing a heredity that exhibits itself in the destruction of mind and body. Its malign influence was observed by the ancients long before the production of whisky, or brandy, or other distilled liquors, and when fermented liquors or wines only were known. Aristotle says, 'Drunken women have children like unto themselves,' and Plutarch remarks, 'One drunkard is the father of another.' The drunkard by inheritance is a more helpless slave than his progenitor, and his children are more helpless still, unless on the mother's side there is an untainted blood. For there is not only a propensity transmitted, but an actual disease of the nervous system." —(*Dr. Willard Parker.*)

PRACTICAL QUESTIONS.

1. How do clothing and shelter economize food?
2. Is it well to take a long walk before breakfast?
3. Why is warm food easier to digest than cold?
4. Why is salt beef less nutritious than fresh?
5. What should be the food of a man recovering from a fever?
6. Is a cup of black coffee a healthful close to a hearty dinner?
7. Should ice-water be used at a meal?
8. Why is strong tea or coffee injurious?
9. Should food or drink be taken hot?
10. Are fruit-cakes, rich pastry, and puddings wholesome?
11. Why are warm biscuit and bread hard of digestion?
12. Should any stimulants be used in youth?
13. Why should bread be made spongy?
14. Which should remain longer in the mouth, bread or meat?
15. Why should cold water be used in making soup, and hot water in boiling meat?
16. Name the injurious effects of over-eating.
17. Why do not buckwheat cakes, with syrup and butter, taste as well in July as in January?

18. Why is a late supper injurious?

19. What makes a man "bilious"?

20. What is the best remedy? *Ans.* Diet to give the organs rest, and active exercise to arouse the secretions and the circulation.

BLACKBOARD ANALYSIS.

DIGESTION AND FOOD.

1. WHY WE NEED FOOD.
2. WHAT FOOD DOES.
3. KINDS OF FOOD.
   1. Nitrogenous.
   2. Carbonaceous
      - a. The Sugars.
      - b. The Fats.
   3. Minerals
4. ONE KIND IS INSUFFICIENT.
5. OBJECT OF DIGESTION.
6. PROCESS OF DIGESTION
   - — General Plan.
   1. Mastication.
      - a. The Saliva.
      - b. Process of Swallowing.
   2. Gastric Digestion
      - a. The Stomach
      - b. The Gastric Juice.
      - c. The Chyme.
   3. Intestinal Digestion
      - — Description.
      - a. The Bile.
      - b. The Pancreatic Juice.
      - c. The Small Intestine.
   4. Absorption
      - a. By the Veins.
      - b. By the Lacteals.
7. HYGIENE
   1. Length of Time required.
   2. Value of different kinds of Food.
   3. The Stimulants.
      - a. Coffee.
      - b. Tea.
   4. Cooking of Food.
   5. Rapid Eating.
   6. Quantity and Quality of Food.
   7. When Food should be taken.
   8. How " " "
   9. Need of a Variety.
8. THE WONDERS OF DIGESTION.
9. DISEASES
   1. Dyspepsia.
   2. The Mumps.
10. ALCOHOLIC DRINKS AND NARCOTICS.
    - 1. Alcohol.
      1. Is Alcohol a Food?
      2. Effect upon the Digestion.
      3. " " " Liver.
      4. " " " Kidneys.
      5. Does Alcohol impart Heat?
      6. " " " Strength?
      7. The Effect upon the Waste of the Body.
      8. Alcohol creates a progressive appetite for itself.
      9. The Law of Heredity.

...in 3 lbs. 8 or 3½ lbs.

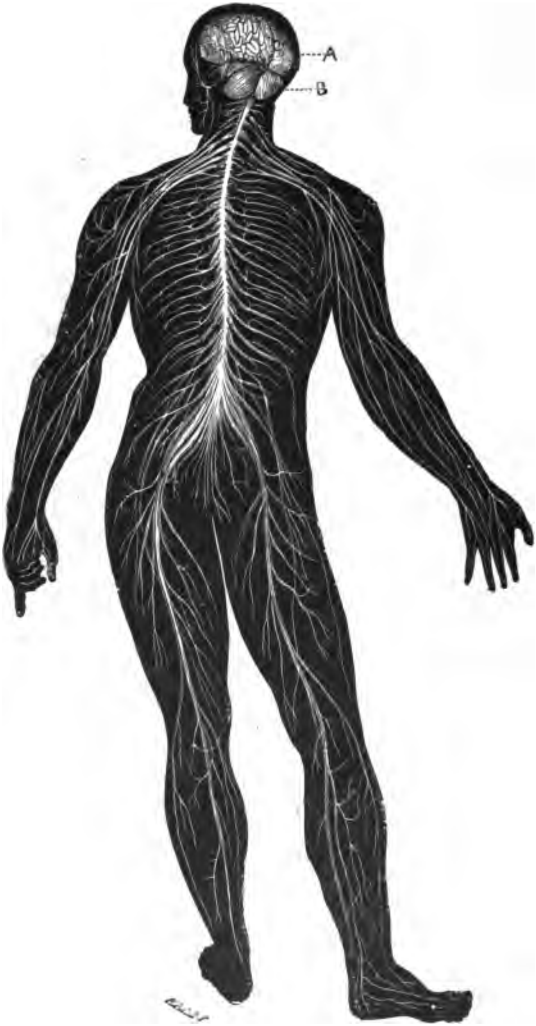
[illegible]

THE NERVOUS SYSTEM.

STRUCTURE.—The nervous system includes the *brain*, the *spinal cord*, and the *nerves*. It is composed of two kinds of matter—the *white*, and the *gray*. The former consists of milk-white, glistening fibers, sometimes as small as $\frac{1}{25,000}$ of an inch in diameter; the latter is a jelly-like substance, made up of small, ash-colored cells. This often gathers in little masses, termed ganglions (*ganglion*, a knot), because when a nerve passes through a group of the cells, they give it the appearance of a knot. The gray cells produce the nervous force, and the nerve fibers conduct it. The ganglia answer to the stations along a telegraphic line, where messages are received and forwarded; the fibers correspond to the wires.

The Brain is the seat of the mind. Its average weight is about fifty ounces. Egg-shaped and yielding, it fills closely the cavity of the skull. It rests on a water-bed, being surrounded by a double membrane, delicate as a spider's web, which forms a sac filled with a liquid resembling water. Within this, closely wrapping the brain, is a fine tissue (*pia mater*), with a mesh of blood-vessels which dips down into the hollows, and bathes them so copiously

Fig. 42.

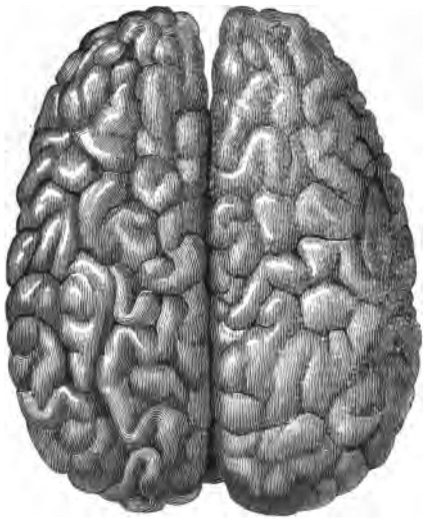


The Nervous System. A, *cerebrum;* B, *cerebellum.*

that it uses one-fifth of all the blood in the body. Around the whole is wrapped a tough membrane (*dura mater*), which lines the bony box of the skull, and separates the various parts of the organ by strong partitions. The brain consists of two parts—the *cerebrum*, and the *cerebellum*.

The Cerebrum fills the front and upper part of the skull, and comprises about seven-eighths of the entire weight of the brain. It is divided into two

Fig. 13.



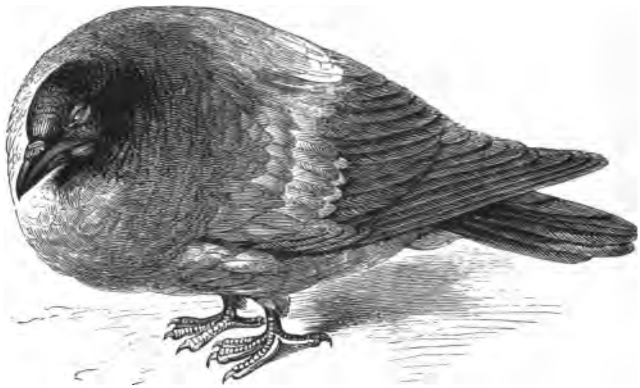
Surface of the Cerebrum.

hemispheres, connected beneath by fibers of white matter. Thus we have two brains, as well as two hands and two eyes. As animals rise in the scale of life, this higher part makes its appearance. It is a mass of white fibers, with cells of gray matter

sprinkled on the outside, or lodged here and there in ganglia. It is curiously wrinkled and folded, much like the meat of an English walnut. This structure gives a large surface for the gray matter. The wrinkles, which are very slight in infancy, increase in size and number according to the mental growth and ability of each individual.

The cerebrum is the center of intelligence and

Fig. 44.



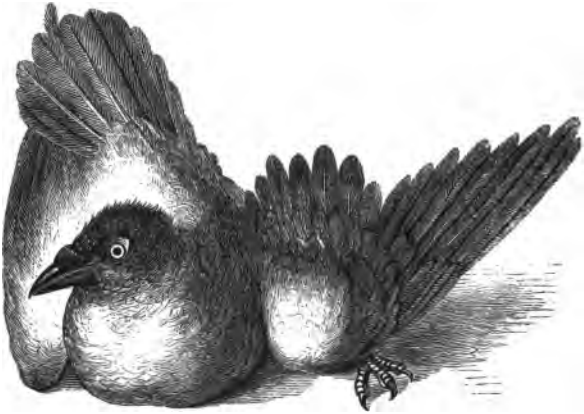
Pigeon from which the Cerebrum has been removed.

thought. Pigeons from which it is removed fall into a profound stupor, occasionally opening their eyes with a vacant stare, and then relapsing into apathy.

The Cerebellum lies below the cerebrum, and in the back part of the head (Fig. 42). It is about the size of a small fist. Its structure resembles that of the brain proper, but instead of wrinkles it has parallel ridges, which, letting the gray matter down deeply into the white matter within, give it a peculiar appearance, called the *arbor-vitæ,* or tree of life

(Fig. 47). This part of the brain controls the voluntary muscles. Pigeons from which it is removed

Fig. 46.



Pigeon from which the Cerebellum has been removed.

are excited, nervous, and try to escape with uncertain, sprawling movements.

The Spinal Cord occupies the cavity of the backbone. It is protected by the same membranes as the brain, but, unlike it, the white matter is on the outside, and the gray matter is within. Deep fissures separate it into halves (Fig. 42), joined by a bridge of the same substance. Just as it starts from the brain, there is an expansion called the *medulla oblongata* (Fig. 47).

The Nerves are glistening, silvery threads, composed, like the spinal cord, of white matter without and gray within. They go to all parts of the body, and though often very near each other, yet are perfectly distinct, each conveying its own impression.

Experiment.—Press two fingers together, and, closing the eyes, let some one pass the point of a pin lightly from one to the other; you will be able to tell which is touched, yet if the nerves came in contact with each other anywhere in their long route to the brain, you could not thus distinguish.

Those nerves which carry the orders of the mind to the different organs are called the *motory* nerves; those which bring back information are styled *sensory* nerves. If the sensory nerve leading to any part be cut, all sensation in that spot will be lost, while motion will remain; if the motory nerve be cut, all motion will be destroyed, while sensation will exist.

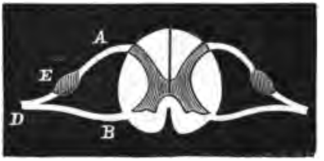
Transfer of Pain.—Strictly speaking, pain is not in any organ, but in the mind, since only that can feel. When any nerve brings to the brain news of an injury, the mind locates the pain at the end of the nerve. A familiar illustration is seen in the "funny bone" behind the elbow. Here the nerve (*ulnar*) gives sensation to the third and fourth fingers, in which, if this bone be struck, the pain will seem to be. Long after a limb has been amputated, it will still seem to give pain,—any injury in the stump being referred to the point to which the nerve formerly led.

The nerves are divided into three general classes—the *spinal*, the *cranial*, and the *sympathetic*.

The Spinal Nerves, of which there are thirty-one pairs, issue from the spinal cord through openings provided for them in the backbone. Each nerve arises by two roots—the motory, and the sensory. These roots are soon bound together in one sheath, though they retain their special functions. When the sensory root of a spinal nerve is cut, the animal

loses the power of feeling, and when the motory root is cut, that of motion.

Fig. 46.



A, *posterior (sensory) root of a spinal nerve;* E, *ganglion;* B, *anterior (motory root;* D, *spinal nerve. The white portions of the figure represent the white fibers; and the dark, the gray.*

The Cranial Nerves, twelve pairs in number, spring from the lower part of the brain and the medulla oblongata. (See Fig. 47.)

1. The *olfactory*, or first pair of nerves, ramify through the nostrils, and are the nerves of smell.

2. The *optic*, or second pair of nerves, pass to the eyeballs, and are the nerves of vision.

3, 4, 6. The *motores oculi* (eye-movers) are three pairs of nerves used to move the eyes.

5. The *tri-facial*, or fifth pair of nerves, divide each into three branches —hence the name: the first to the upper part of the face, eyes, and nose; the second to the upper jaw and teeth; the third to the lower jaw and the mouth, where it forms the nerve of taste. These nerves are implicated when we have the toothache or neuralgia.

7. The *facial*, or seventh pair of nerves, are distributed over the face, and give it expression.

8. The *auditory*, or eighth pair of nerves, go to the ears, and are the nerves of hearing.

9. The *glos-so-pha-ryn'-ge-al*, or ninth pair of nerves, are distributed over the mucous membrane of the pharynx, tonsils, etc.

10. The *pneu-mo-gas'-tric*, or tenth pair of nerves, preside over the larynx, lungs, and stomach, one branch extending to the heart. This is the only nerve that goes so far from the head.

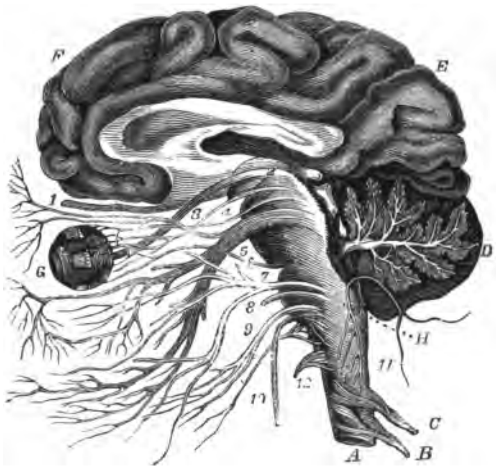
11. The *accessory*, or eleventh pair of nerves, regulate the vocal movements of the larynx.

12. The *hyp-o-glos'-sal*, or twelfth pair of nerves, give motion to the tongue.

The Sympathetic System contains the nerves of organic life. It consists of a double chain of ganglia

on either side of the backbone, extending into the chest and abdomen. From these, delicate nerves

Fig. 47.



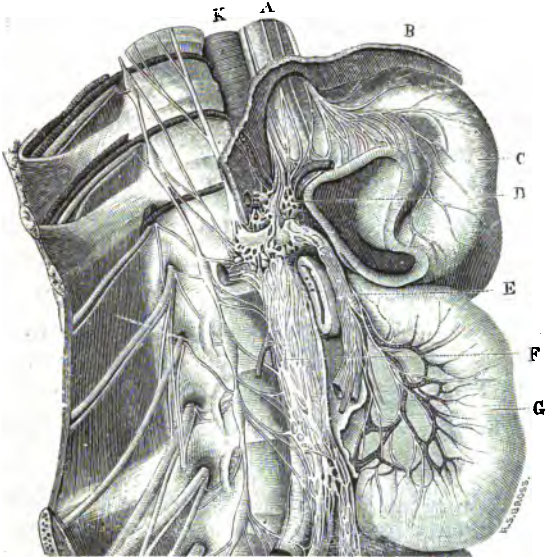
The Brain and the origin of the twelve pairs of Cranial Nerves. F, E, *the Cerebrum;* D, *the cerebellum, showing the arbor-vitæ;* G, *the eye;* H, *the medulla oblongata;* A, *the spinal cord;* C *and* B, *the first two pairs of spinal nerves.*

run to the organs on which life depends—the heart, lungs, stomach, etc., to the blood-vessels, and to the spinal and cranial nerves over the body. Thus the entire system is bound together by cords of sympathy, so that, "if one member suffers, all the members suffer with it."

Crossing of Cords.—Each half of the body is presided over, not by its own half of the brain, but that of the opposite side. (1) The motory nerves, as they descend from the brain, in the medulla oblongata cross each other and pass to the opposite side of the spinal cord. So the motor-nerves of the right side

of the body are connected with the left side of the brain, and *vice versa*. Thus a derangement in one

Fig. 48.



Spinal Nerves, Sympathetic Cord, and the Net-work of Sympathetic Nerves around the Internal Organs. K, *aorta;* A, *œsophagus;* B, *diaphragm;* C, *stomach.*

half of the brain paralyzes the opposite half of the body. (2) Each of the sensory fibers of the spinal nerves crosses over to the opposite side of the spinal cord, and so ascends to the brain.

An injury to the spinal cord may, therefore, cause a loss of motion in one leg and of feeling in the other.

Reflex Action. — We have seen that nervous force arises in the gray matter. A ganglion, therefore, can not only receive an impression, but can

also send it back, i. e., *reflect* it, so as to excite the muscles to action. This is done without reference to the mind. We wink involuntarily at a flash of light or a threatened blow; we start at a sudden sound; we jump back from a precipice before the mind has time to reason upon the danger. Thus, the spinal cord conducts certain impressions to the brain, but responds to others without troubling that organ.

Uses of Reflex Action.—We breathe eighteen times every minute; we stand, walk, eat, digest, and, at the same time, carry on a train of thought,—all without a consciousness of effort. Our brain is thus freed from the petty detail of life. If we were obliged to attend to every breath, every pulsation of the heart, every wink of the eye, our time would be wasted in keeping alive. Besides, an act which at first is difficult, soon grows easy, and, at last, becomes mechanical, *i. e.*, reflex. All the possibilities of education and the power of forming habits are based upon this principle. No act we perform ends with itself. It leaves behind it in the nervous centers a tendency to do the same thing again. Our physical being thus fixes upon us the habits of a good or an evil life. Our very thoughts, even, are written in our muscles, so that not only the expression of our face, but our features themselves betray our hidden life. Nature is intent upon hanging out sign-boards to show what kind of a person we are.

Brain Exercise.—The nervous system demands activity. The mind grows by what it feeds on. Hence, the girl who lolls on the sofa, reading romantic novels, or who devotes her life to fashionable

follies, will physically and mentally weaken; while the boy who idles about the streets, smoking cigarettes, and who reads only tales of crime and adventure, may be equally sure of mental poverty and bodily weakness. On the other hand, excessive study exhausts the vital force, and the weakened body, reacting on the brain, produces gradual decay and serious disease.

Sleep is as essential as food. During the day, the process of tearing-down goes on; during the night, the work of building-up should make good the loss. In youth more sleep is needed than in old age. The number of hours required must be decided by each person; Napoleon took only five hours, but most people need from six to eight hours,—brain-workers even more. In general, one should sleep until he naturally wakes.

Sleep produced by medicine is rarely as beneficial as natural sleep, for the disturbance to the nervous system often counterbalances the good results of slumber. The habit of acquiring sleep in this way, without the advice of a physician, is extremely dangerous, as the dose must be constantly increased to cause the effect; where laudanum or morphine is used, the person often falls, unawares, into a terrible and fatal bondage. Infants, especially, should never be dosed with cordials. Frightful injury is heaped on helpless childhood by the reckless use of soothing-syrups. All ordinary sleeping-draughts have life-destroying properties, as is proved by the fatal effects of an overdose. At the best, they paralyze the nerve centers, disorder the digestion, and poison the blood.

Sunlight has a marked effect upon the nervous system. All vigor and activity come from the sun. Vegetables grown in subdued light have a bleached and faded look. An infant kept in absolute dark-

ness would grow into a shapeless idiot. That room is the healthiest to which the sun has the freest access. Epidemics frequently attack the inhabitants of the shady side of a street, and totally exempt those on the sunny side. If, on a slight indisposition, we should go out into the open air and bright sunlight, instead of shutting ourselves up in a close, dark chamber, we might often avoid a serious illness. The sun-bath is an efficient remedy for many diseases. Our window blinds and curtains should be thrown open, and we should let the blessed air and sun stream in to invigorate and cheer. No house buried in shade, and no room with darkened windows, is fit for human habitation. In damp and darkness, lies in wait almost every disease to which flesh is heir. The sun is their only successful foe.

Wonders of the Brain.—After having seen the beautiful contrivances and the exquisite delicacy of the lower organs, it is natural to suppose that when we come to the brain we should find the most elaborate machinery. How surprising, then, it is to have revealed to us only cells and fibers! The brain is the least solid and most unsubstantial looking organ in the body. Eighty per cent. of water, seven of albumen, some fat, and a few minor substances make up the instrument which rules the world. Strangest of all, the brain, which is the seat of sensation, is itself without sensation. Every nerve, every part of the spinal cord, is keenly alive to the slightest touch, yet "the brain may be cut, burned, or electrified without producing pain."

ALCOHOLIC DRINKS AND NARCOTICS.

ALCOHOL (Continued from p. 113).

Effect upon the Nervous System.—When a person takes alcohol into his stomach, its influence upon the nervous system is marked by four successive stages.

1. The Stage of Excitement.—The first effect, as we have already seen, is to paralyze the nerves that regulate the passage of the blood through the capillaries. The vital force, thus drawn into the nervous centers, drives the machinery of life with tremendous energy. The blood surges through the body with increased violence. Every capillary tube in the system is swollen and flushed, like the reddened nose and cheek.

In all this there is excitement, but no nourishment, no permanent power conferred on brain or muscle. Alcohol may cheer for the moment. It may set the sluggish blood in motion, start the flow of thought, and excite a temporary gayety. "It may enable a wearied or feeble organ to do brisk work for a short time. It may make the brain briefly brilliant. It may excite muscle to quick action, but it does nothing at its own cost, fills up nothing it has destroyed, and itself leads to destruction." Even the mental activity it excites is an unsafe state of mind, for that even balance of the faculties so essential to good judgment is disturbed by the presence of the intruder. Johnson well remarked, "Wine improves conversation by taking the edge off the understanding."

2. THE STAGE OF MUSCULAR WEAKNESS.—If the action of the alcohol be still continued, the spinal cord is next affected by this powerful narcotic. The control of some of the muscles is lost. Those of the lower lip usually fail first, then those of the lower limbs, and the staggering, uncertain steps betray the result. The muscles themselves, also, become feebler as the power of contraction diminishes. The temperature, which, for a time, was slightly increased, soon begins to fall as the heat is radiated; the body is cooled, and the well-known "alcoholic chill" is felt.

3. THE STAGE OF MENTAL WEAKNESS.—The cerebrum is now affected. The ideal and emotional faculties are quickened, while the will is weakened. The center of thought being overpowered, the mind is a chaos. Ideas flock in thick and fast. The tongue is loosened. The judgment loses its hold on the acts. The reason giving way, the animal instincts generally assume the mastery of the man. The hidden nature comes to the surface. All the gloss of education and social restraint falls off, and the lower nature stands revealed. The coward shows himself more craven, the braggart more boastful, the bold more daring, and the cruel more brutal. The inebriate is liable to commit any outrage that the slightest provocation may suggest.

4. THE STAGE OF UNCONSCIOUSNESS. — At last, prostration ensues, and the wild, mad revel of the drunkard ends with utter senselessness. In common speech, the man is "dead drunk." Brain and spinal cord are both benumbed. Fortunately, the two nerv-

ous centers which supply the heart and the diaphragm are the slowest to be influenced. So, even in this final stage, the breathing and the circulation still go on, though the other organs have stopped. Were it not for this, every person thoroughly intoxicated would die.—(*Richardson.*)

Effect upon the Brain.—Alcohol seems to have a special affinity for the brain. This organ absorbs more than any other, and its delicate structure is correspondingly affected. The congestion here reaches its height. The tiny vessels become clogged with blood that is loaded with carbonic acid, and scantily supplied with the life-giving oxygen.—(*Hinton.*) The mind slowly rallies from the stupor of the fourth stage, and a lingering sense of dullness and depression shows with what difficulty the fatigued brain recovers its usual condition. So marked is the effect of the narcotic poison that some authorities hold that "a once thoroughly-intoxicated brain never fully becomes what it was before."

The deadening of the nerves, which occurs even in the first stage, is full of peril. Pain is said to be "the cry of the body for healthy blood." Whenever anything goes amiss in any part of the system, a despatch is sent at once to the brain, and we feel uneasy, often miserable, till the cause is removed. Alcohol deadens this "physical conscience," and its unfortunate victim goes on ruining his health without knowing it.

In time, the free use of liquor hardens and thickens the membranes which envelop the nervous matter; the nerve-cells undergo a "fatty degeneration"; the

blood-vessels, from long congestion, lose their elasticity; and the vital fluid, flowing less freely through the obstructed channels, fails to afford the old-time nourishment. The consequent decay of the nervous substance shows itself in the weakened mind we so often notice in a person accustomed to drink, and at last results in various nervous disorders—epilepsy, paralysis, and insanity. The law of heredity here asserts itself again, and the inebriate's children often inherit the disease which he has escaped.

Chief among the consequences of this imperfect nutrition of the brain is that state between intoxication and insanity, known as *Delirium Tremens.* "It is marked by a restless activity of the cerebrum, manifesting itself in muttering delirium, with occasional violent paroxysms. The victim apprehends some direful calamity; he imagines his bed to be covered with loathsome reptiles; he sees the walls of his apartment crowded with foul specters; and he imagines his friends and attendants to be fiends come to drag him down to a fiery abyss beneath."—(*Carpenter.*)

Influence upon the Mental and Moral Powers.—The effect of alcoholized blood is to weaken the will. The one habitually under its influence often shocks us by his indecision and broken promises of reform. The truth is, he has lost, in a measure, his power of self-control. At last, he becomes physically unable to resist the craving demand of his morbid appetite.

Other faculties share in this mental wreck. The intellectual vision becomes less penetrating, the grasp of thought is less vigorous, and the decisions

of the mind are less reliable. A thriftless, reckless feeling is developed, and all self-respect is lost.

Along with this mental degradation comes also a failure of the moral sense. The fine fiber of character undergoes a "degeneration" as certain as that of the muscles themselves. The broken promises tell of a lowered standard of truth and a dulled sense of honor, quite as much as of an impaired will. Conscience is lulled to rest. Reason is enfeebled. Customary restraints are thrown off. The sensibilities are blunted. There is less ability to appreciate nice shades of right and wrong. Great moral principles and motives lose their power to influence. The better nature has been dethroned.

The wretched victim of appetite will now gratify his passion for drink at any expense of deceit or crime. He becomes the blind instrument of his insane impulses, and commits acts from which he would once have shrunk with horror. Sometimes he even takes a malignant pleasure in injuring those whom Nature has ordained he should protect.

Summary.—Richardson sums up the various diseases caused by alcohol as follows: "(*a*). Diseases of the brain and nervous system, indicated by such names as apoplexy, epilepsy, paralysis, vertigo, softening of the brain, delirium tremens, dipsomania or inordinate craving for drink, loss of memory, and that general failure of the mental power, called dementia. (*b*). Diseases of the lungs: one form of consumption, congestion, and subsequent bronchitis. (*c*). Diseases of the heart: irregular beat, feebleness of the muscular walls, dilatation, disease of the valves. (*d*). Diseases of the blood: scurvy, excess of water or dropsy, separation of fibrin. (*e*). Diseases of the stomach: feebleness of the stomach, indigestion, flatulency, irritation, and sometimes inflammation. (*f*). Diseases of the bowels: relaxation or purging, irritation. (*g*). Diseases of the liver: congestion,

hardening and shrinking, cirrhosis. (*h*). Diseases of the kidneys: change of structure into fatty or waxy-like condition and other results leading to dropsy, or sometimes to fatal sleep. (*i*). Diseases of the muscles; fatty change in the muscles, by which they lose their power for proper active contraction. (*j*). Diseases of the membranes of the body: thickening and loss of elasticity, by which the parts wrapped up in the membrane are impaired for use, and premature decay is induced."

II. TOBACCO.

The Chief Constituents of Tobacco are carbonic acid, carbonic oxide, and ammonia gases; carbon, or soot; and nicotine. Carbonic acid tends to produce sleepiness and headache. Carbonic oxide, in addition, causes a tremulous movement of the muscles, and so of the heart. Ammonia bites the tongue of the smoker, excites the salivary glands, and causes dryness of the mouth and throat. Nicotine is a powerful poison. The amount contained in one or two strong cigars, if thrown directly into the blood, would cause death.

Physiological Effects.—The poison of tobacco, set free by the process either of chewing or smoking, when for the first time swept through the system by the blood, powerfully affects the body. Nausea is felt, and the stomach seeks to throw off the offending substance. The brain is inflamed, and headache follows. The motor-nerves becoming irritated, giddiness ensues. Thus Nature earnestly protests against the formation of this habit. But, after repeated trials, the system adjusts itself to the new conditions. Such powerful substances cannot, however, be constantly inhaled without producing marked changes. The three great eliminating

organs—the lungs, the skin, and the kidneys—throw off a large part of the products, but much remains in the system. When the presence of the poison is constant, and especially when smoking or chewing is excessive, the temporary disturbance leads to chronic derangement.

In this, as in the case of other injurious articles of diet, the strong and healthy sometimes seem to escape entirely, while the weak and those predisposed to disease suffer according to the extent of the indulgence. Those who lead an active, outdoor life often show no sign of nicotine poisoning, but the man of sedentary habits will sooner or later be the victim of dyspepsia, sleeplessness, nervousness, paralysis, or some other organic difficulty. Here, again, the law of heredity asserts itself, and though the tobacco-user himself escapes, his innocent offspring only too often inherit an impaired constitution, and a tendency to nervous disease.

The Various Disturbances produced in different individuals and constitutions by smoking have been summed up by Dr. Richardson as follows: "(*a*) In the blood, it causes undue fluidity, and change in the red corpuscles; (*b*) in the stomach, it gives rise to debility, nausea, and vomiting; (*c*) in the mucous membrane of the mouth, it produces enlargement and soreness of the tonsils—smoker's sore-throat—redness, dryness, and occasional peeling of the membrane, and either unnatural firmness and contraction, or sponginess of the gums; and, where the pipe rests on the lips, oftentimes 'epithelial cancer;' (*d*) in the heart, it causes debility of the organ, and irregular action; (*e*) in the bronchial surface of the lungs, when that is already irritable, it sustains irritation, and increases the cough; (*f*) in the organs of sense, it produces dilation of the pupils of the eye, confusion of vision, bright lines, luminous or cobweb specks, and long retention of images on the retina, with analogous symptoms affecting the ear,

viz.: inability to define sounds clearly, and the occurrence of a sharp, ringing noise like a whistle; (*g*) in the brain, it impairs the activity of the organ, oppressing it if it be nourished, but soothing it if it be exhausted; (*h*) it leads to paralysis in the motor and sympathetic nerves, and to over-secretion from the glands which the sympathetic nerves control."

CIGARETTES are especially injurious from the irritating smoke of the paper covering, and also because the poison-fumes of the tobacco are more directly inhaled. In the cheap cigarettes often smoked by boys, the ingredients are harmful, while every youth would revolt if he knew what filthy materials, refuse cigar-stumps, &c., are used in their manufacture.

Is Tobacco a Food?—Tobacco cannot impart to the blood an atom of nutritive matter for building up the body. It does not add to, but rather subtracts from, the total vital force. It confers no power upon muscle or brain. It stimulates by cutting off the nervous supply from the extremities and concentrating it upon the centers. But stimulation is not nourishment; it is only a rapid spending of the capital stock. There is no greater error than to mistake the exciting of an organ for its strengthening.

The Influence upon Youth.—Here, too, science and experience assert only one conviction. *Tobacco retards the development of mind and body.* The law of nature is that of steady growth. It cannot admit of a daily disturbance that weakens the digestion, that causes the heart to labor excessively, that prevents the perfect oxidation of the blood, that interferes with the digestion, and that deranges the nervous system. No one has a right thus to check and disturb his physical and mental progress. Hence, the young man (especially if he be of a nervous, sensitive organization) who uses tobacco diminishes the possible energy with which he might commence the

work of life; while he comes under the bondage of a habit that may become stronger than his will, and under the influence of a narcotic that may beguile his faculties and palsy his strength at the very moment when every power should be awake.

Another peril lies in the wake of this masterful poison-habit. Tobacco causes a thirst and depression that only too often lead to the use of liquor.

III. OPIUM.

Opium is the dried juice of the poppy. In Eastern countries, this flower is cultivated in immense fields. When a cut is made in the poppy-head, a tiny tear of milky juice exudes, and hardens. These little drops are gathered and prepared for the market. Throughout the East, opium is generally smoked; but in Western countries, it is taken usually in the form of laudanum, paregoric, and morphine. The drug itself is also eaten.

Physiological Effect.—Opium, in its various forms, acts directly upon the nerves, a small dose quieting pain, and a larger one soothing to sleep. It arouses the brain, and fires the imagination to a wonderful pitch. The reaction from this unnatural excitant is correspondingly depressing; and the "overwhelming horror" that ensues, calls for a renewal of the stimulus. The dose must be gradually increased to produce the original effect, and must be taken at the habitual hour, no matter what the circumstances, under the penalty of almost unendurable agony.

The seductive nature of this drug leads on its unfortunate victim step by step, until he finds himself

fast bound in the fetters of the most tyrannical habit known to man. To continue, is to wreck all one's powers—physical and mental; to stop, requires a strength of will that few possess. Even when the habit is broken, the system is long in recovering from the shock. Opium seems to be the foe of every organ. The digestion is weakened, the appetite is lost, the muscles waste, the skin shrivels, the nervous centers are paralyzed, and a premature old age comes on apace.

No person can be too careful in the use of laudanum, paregoric, and morphine. They should never be taken except on a physician's prescription. If followed up for any length of time, the habit may be formed ere one is aware. Then comes the opium-eater's grave, or the opium-eater's struggle for life!

Many persons learn to inject morphine beneath the skin by means of a "hypodermic syringe." The operation is painless, and seems innocent enough. It throws the narcotic directly into the circulation, and relief from pain almost instantly follows. But the danger of forming the opium habit is not lessened, and the effect of using the drug in this form for a long time is just as injurious as opium-smoking itself.

IV. CHLORAL HYDRATE.

Chloral Hydrate is a drug frequently used to cause sleep. It leaves behind no headache or lassitude, as is often the case with morphine. It is, however, a treacherous remedy. Even a small and harmless dose, persisted in for a long period, may produce a gradual accumulation of evil results that in the end will prove fatal.

The Physiological Effect is very marked. The

appetite becomes capricious. The secretions are unnatural. Nausea often ensues. Then the nervous system is involved. The heart is affected. Sleep is broken. Finally the blood becomes unduly fluid, as it does in the case of persons deprived of fresh food. A disease resembling scurvy follows, and the skin breaks out in unsightly blotches.

V. CHLOROFORM.

Chloroform is a powerful anæsthetic. It is sometimes prescribed by a physician, and afterward (as in the case of laudanum, morphine, and chloral) the sufferer, charmed with the release from pain and the peaceful slumber secured, buys the dangerous drug for himself. Its use soon becomes an apparent necessity. As with opium, the craving for the narcotic at a stated time is almost irresistible. If it be withheld, the half-frantic patient will demand, entreat, pray for another dose, in a manner never to be forgotten. Paleness and debility, the earliest symptoms, are followed by mental prostration. Familiarity with the dangerous drug begets carelessness. Its victims are frequently found dead in their beds, with the handkerchief from which they inhaled the volatile poison clutched in their lifeless hands.

PRACTICAL QUESTIONS.

1. Why is the pain of incipient hip-disease frequently felt in the knee?
2. Why does a child require more sleep than an aged person?
3. When you put your finger in the palm of a sleeping child, why will he grasp it?
4. How may we strengthen the brain?

5. What is the object of pain?

6. Why will a blow on the stomach sometimes stop the heart?

7. Why can an idle scholar read his lesson and at the same time count the marbles in his pocket?

8. How can we grow beautiful?

9. Why do intestinal worms ever affect a child's sight?

10. Is there any indication of character in physiognomy?

11. When one's finger is burned, where is the ache?

12. Why can we walk and talk at the same time?

BLACKBOARD ANALYSIS.

THE NERVOUS SYSTEM.

- 1. THE STRUCTURE.
- 2. ORGANS OF THE NERVOUS SYSTEM.
  - 1. The brain.........
    - 1. Description.
    - 2. The Cerebrum.
    - 3. The Cerebellum.
  - 2. The Spinal Cord...
    - 1. Its Composition.
    - 2. Medulla Oblongata.
  - 3. The Nerves........
    - 1. Description.
    - 2. Motory and Sensory.
    - 3. Transfer of Pain.
    - 4. The Spinal Nerves.
    - 5. The Cranial Nerves.
    - 6. Sympathetic System.
    - 7. Crossing of Cords.
    - 8. Reflex Action.
    - 9. Uses of Reflex Action.
- 3. HYGIENE.:..........
  - 1. Brain Exercise.
  - 2. Brain-growth and Body-growth.
  - 3. Sleep.
  - 4. Effect of Sleeping-draughts.
  - 5. Sunlight.
- 4. WONDERS OF THE BRAIN.
- 5. ALCOHOLIC DRINKS, AND NARCOTICS.
  - 1. Alcohol (cont'd.)
    - 1. Effect upon the Nervous System.
    - 2. Effect upon the Brain.
    - 3. Effect upon Mental and Moral Powers.
  - 2. Tobacco.
    - 1. Constituents of Tobacco.
    - 2. Physiological Effects.
    - 3. Influence upon the Nervous System.
    - 4. Disturbances produced by smoking.
    - 5. Is Tobacco a Food?
    - 6. Influence of Tobacco upon Youth.
  - 3. Opium.
  - 4. Chloral Hydrate.
  - 5. Chloroform.

THE SPECIAL SENSES.

1. TOUCH.

DESCRIPTION.—Touch is sometimes called the "common sense," since its nerves are spread over the whole body. It is most delicate, however, in the point of the tongue and the tips of the fingers. The surface of the cutis is covered with minute projections called *papillæ* (Fig. 20). Each of these contains its tiny nerve-twigs, that receive the impression and send it to the brain.

Experiment.—With a pocket-lens, examine the palm of the hand, where there are at least 12,000 papillæ in a square inch, and note the fine ridges along which they are arranged.

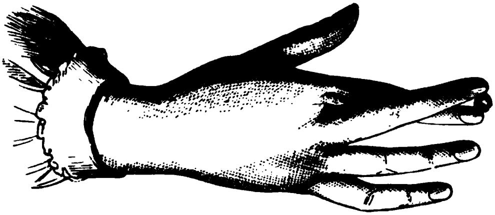
Uses.—Touch is the first of the senses used by a child. By it we obtain our idea of solidity, and also correct the impressions made upon us by the other senses. Thus, when we see anything curious, our first desire is to handle it. The sensation of touch is generally relied upon, yet it is easily deceived.

Experiments.—1. Hold a marble in the manner shown in Fig. 49. It will seem like two marbles. 2. Touch the fingers thus crossed to your tongue. You will feel two tongues. 3. Close your eyes and let another

person move one of your fingers over a plane surface, first lightly, then with greater pressure, and then lightly again. You will think the surface concave.

This sense is capable of wonderful cultivation, and the delicacy of touch possessed by the blind almost compensates the loss of their eyes. The sympathy

Fig. 49.



between all the different organs shows how they combine to make a home for the mind. When one sense fails, the others try to remedy the defect. It is touching to see how the blind man gets along without eyes, and the deaf without ears. Cuthbert, though blind, was the best polisher of telescopic mirrors in London. There is an instance recorded of a blind man who could recognize colors. The author knew one who said he could tell when he was approaching a tree, "by the different feeling of the air."

2. TASTE.

Description.—This sense is located in the papillæ of the tongue and palate.

Experiment.—Put a drop of vinegar on another person's tongue, or on your own before a mirror, and notice how the papillæ rise.

The velvety look of the tongue is given by hair-like projections of the cuticle upon some of the papillæ. They absorb the liquid to be tasted, and convey it to the nerves. A substance that will not dissolve is tasteless.

The back of the tongue is most sensitive to salt

Fig. 50.

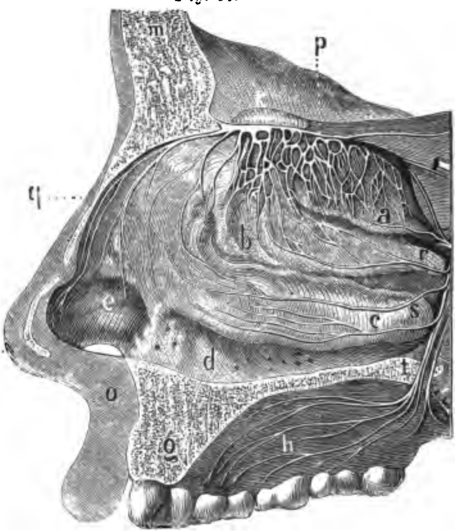
The Tongue, showing the three kinds of Papillæ—the conical (D), *the whip-like* (K, I), *the circumvallate or entrenched* (H, L); E, F, G, *nerves*; C, *glottis.—Lankester.*

and bitter tastes, and, as this part is supplied by the ninth pair of nerves (Fig. 47), which is in sympathy

with the stomach, such flavors often produce vomiting. The edges of the tongue are most sensitive to sweet and sour substances, and, as this part is supplied by the fifth pair of nerves, which also goes to the face, an acid distorts the countenance.

The Use of the Taste was originally to guide in the selection of food; but it has become so depraved by condiments and habit that it would be difficult to tell what are one's natural tastes.

Fig. 51.



A, b, c, d, *interior of the nose, which is lined by a mucous membrane;* n, *the nose;* e *the wing of the nose:* q, *the nose bones;* o, *the upper lip;* g, *section of the upper jaw-bone;* h, *the upper part of the mouth, or hard palate;* m, *frontal bone of the skull;* k, *the ganglion or bulb of the olfactory nerve in the skull, from which are seen the branches of the nerve passing in all directions.*

3. SMELL.

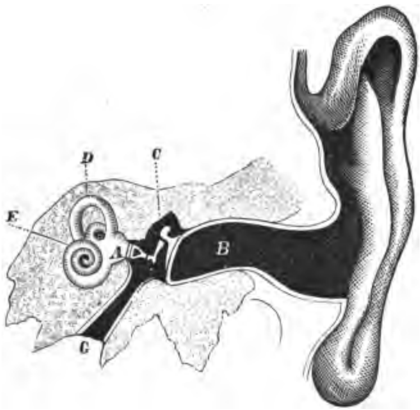
Description.—The olfactory nerves (first pair, Fig. 47) enter through a sieve-like, bony plate at the roof

of the nose, and are distributed over the inner surface of the two olfactory chambers. The object to be smelled need not touch the nose, but tiny particles borne on the air enter the nasal passages.

The Uses of the sense of smell are to guide us in the choice of our food, and to warn us against bad air, and unhealthy localities.

4. HEARING.

Fig. 52.



The Ear.

Description.—The ear is divided into the *external, middle,* and *internal* ear.

1. THE EXTERNAL EAR is a sheet of cartilage curiously folded for catching sound. The auditory canal, *B,* or tube of this ear-trumpet, is about an inch long. Across the lower end is stretched *the membrane of the tympanum* or drum, which is kept soft by a fluid wax.

2. THE MIDDLE EAR is a cavity, at the bottom of which is the *Eustachian tube, G*, leading to the mouth. Across this chamber hangs a chain of three singular little bones, *C*, named from their shape the *hammer*, the *anvil*, and the *stirrup*. Though these tiny bones weigh all together only a few grains, yet they have two perfect joints,—a ball-and-socket, and a hinge.

3. THE INTERNAL EAR, or labyrinth, is hollowed out of the solid bone. In front, is the vestibule, *A*, about as large as a grain of wheat; from it open three *semi-circular canals, D*, and the winding stair of the *cochlea*, or snail shell, *E*. Here expand the delicate fibrils of the auditory nerve.

Floating in the liquid which fills the labyrinth is a little bag containing hair-like bristles, fine sand, and two ear-stones. In the cochlea are minute tendrils, named the fibers of Corti, from their discoverer. These are regularly arranged,—the longest at the bottom, and the shortest at the top. Could this spiral plate, which coils two and a half times around, be unrolled and made to stand upright, it would form a beautiful microscopic harp of three thousand strings.

How We Hear.—Whenever one body strikes another in the air, waves are produced, just as when we throw a stone into the water a series of circles surrounds the spot where it sinks. These waves of air strike upon the membrane. This vibrates, and sends the motion along the chain of bones in the middle ear to the fluids of the labyrinth. Here bristles, sand, and stones pound away, and the won-

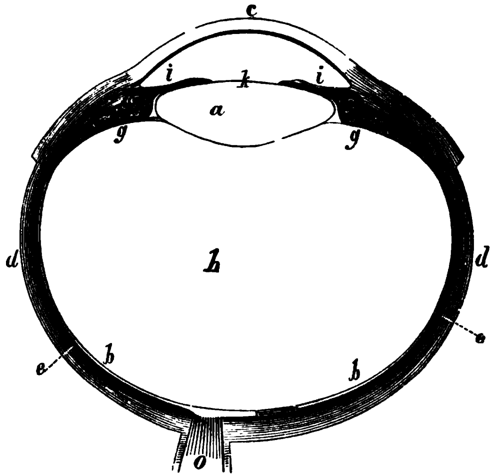
drous harp of the cochlea, catching up the pulsations, carries them to the fibers of the auditory nerve, which conveys them to the brain, and gives the mind the idea of sound. During this process, the original pulsations are mysteriously modified by the bristles, ear-stones, &c., so that they can affect the nerve.

Care of the Ear.—The delicacy of the ear is such that it needs the greatest care. Cold water should not be allowed to enter the auditory canal. If the wax accumulate, never remove it with a hard instrument, lest the delicate membrane be injured, but with a little warm water, after which turn the head to let the water run out, and wipe the ear dry. The hair around the ears should never be left wet, as it may chill this sensitive organ. If an insect get in the external ear, pour in a little oil to kill it, and then remove with tepid water. The object of the Eustachian tube is to admit air into the ear, and thus equalize the pressure on the membrane.

5. SIGHT.

Description.—The eye is lodged in a bony cavity, protected by the overhanging brow. It is a globe, about an inch in diameter. The ball is covered by three coats—(1) the *sclerotic, d,* a tough, horny casing, which gives shape to the eye, the convex, transparent part in front forming a window, the *cornea, c;* (2) the *choroid, e,* a black lining, to absorb the superfluous light; and (3) the *retina, b,* a membrane in which expand fibers of the *optic nerve, o.* The *crys-*

Fig. 53.



The Eye.

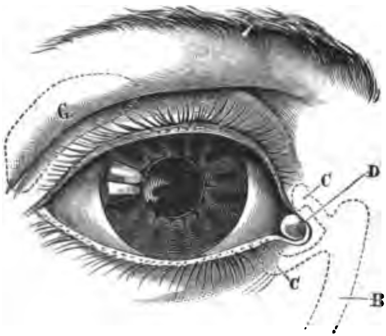
talline lens, a, brings the rays of light to a focus on the retina. Between the cornea and the crystalline lens is a limpid fluid termed the *aqueous humor;* while the *vitreous humor*—a transparent, jelly-like liquid—fills the space (*h*) back of the crystalline lens. The pupil, *k,* is a hole in the colored, muscular curtain, *i,* the *iris* (rainbow).

Experiment.—Take the eye of a freshly slaughtered ox or sheep, and, with a pair of scissors, clip the sclerotic half-way between the cornea and the optic nerve. You can then see the choroid with its black lining, and inside it the vitreous jelly with the retina spread out around it. By a little force the vitreous humor and the lens set in it will come out, and you will see the retina collapse into a whitish mass attached to the point where the optic nerve comes in. In an ox's eye, you will see that a part of the choroid resembles a mirror ;—it is the same with the cat, which causes the shining of her eye in the dark.

The front half of the eye will show you the iris—which is always black at the back, whatever color the front may be,—and the transparent cornea. If you stick a pin into the cornea, the aqueous humor will spirt out.

Eyelids and Tears.—The eyelids are close-fitting shutters to screen the eye. The inner side is lined with a mucous membrane that is exceedingly sensitive, and thus aids in protecting the eye from any irritating substance. The eyelashes serve as a sieve to exclude the dust, and, with the lids, shield against a blinding light. Just within the lashes are oil glands, which lubricate the edges of the lids, and

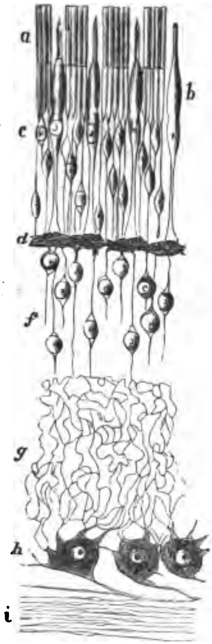
Fig. 54.



The Eyelashes and the Tear-glands.

prevent them from adhering to each other. The tear (*lachrymal*) gland, *G*, is an oblong body lodged in the bony wall of the orbit. It empties by several ducts upon the inner surface, at the outer edge of the upper eyelid. Thence the tears, washing the eye, run into the *lachrymal lake, D*, a little basin with a rounded border fitted for their reception. On each side of this lake, two canals, *C, C*, drain off the overplus through the duct, *B*, into the nose.

Fig. 55.



Structure of the Retina.—a, the rods; b, the cones; c, the nerve-granules; d, a mesh; f, nerve-granules; g, nerve-fibers: h, ganglia: i, fibers of optic nerve.

Structure of the Retina.—In Fig. 55, is shown a section of the retina, greatly magnified. The layer of rods and cones (*a*, *b*,) is to the eye what the bristles, ear-stones, etc., are to the ear, changing the vibrations of light in some mysterious way so that they can affect the nerve. The optic nerve itself is insensible to light. At the point where it enters the eye, there are no rods and cones, and this is called the blind spot.

Experiment.—Hold this book directly before the face, and, closing the left eye, look steadily with the right at the left-hand circle in Fig. 56. Move the book back and forth, and a point will be found where the right-hand circle vanishes from sight. At that moment its light falls upon the spot where the rods and cones are lacking.

How We See.—There is believed to be a kind of atmosphere, termed *ether*, filling all space. This is infinitely more delicate than the air, and occupies its

Fig. 56.

pores, as well as those of all bodies. As sound is caused by waves in the air, so light is produced by waves in the ether. A lamp-light, for example, sets in motion waves of ether, which pass in through the pupil of the eye to the retina, where the rods and cones modify and then transmit the vibration through the optic nerve to the brain, when the mind perceives the light.

The Use of the Crystalline Lens.—A convex lens bends the rays of light which pass through it, so that they meet at a point called the *focus.*

Fig. 57.

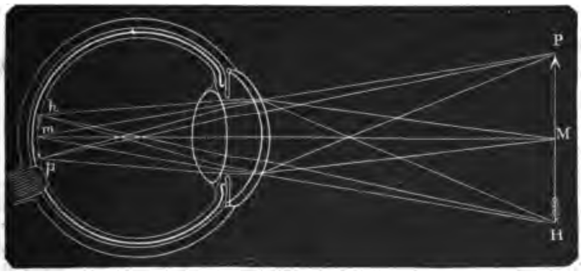


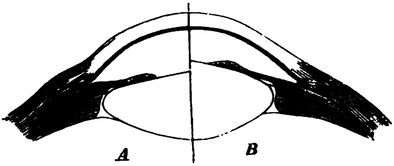
Diagram showing how an image of an object is formed upon the retina by the Crystalline Lens.

Experiments.—1. Hold a common burning-glass or pocket-lens over a piece of black paper under a bright, noon-day sun, and note how it brings the rays to a focus. In the same way, the crystalline lens brings the rays of light that enter the eye to a focus upon the retina. 2. Take a narrow piece of board two feet long. Stick into it two large pins, about twelve or fifteen inches apart, and not in a straight line. Look at the pins along the board somewhat as you would "sight" a gun. If you fix your eye on the nearer pin, you will see it distinctly, but the further one will become blurred. If you look fixedly at the further one, that will become distinct, and the nearer one blurred. By no effort can you make both pins perfectly distinct at the same time. Now look rapidly from one to the other and see how

soon your eye adjusts itself to each. The lens of a healthy eye has this power of adapting itself, by changing its convexity (see Fig. 58), to near and to distant objects, so as exactly to bring the rays of light which come from them to a focus on the retina.

Near and Far Sight.—If, however, the lens of the eye be too convex, it will bring the rays to a focus before they reach the retina; if too flat, they will reach the retina before coming to a focus. In either

Fig. 58.



Adjustment of the Crystalline Lens. A, *for far objects*, *and* B, *for near.*

case, the sight will be indistinct. A more common defect is in the shape of the globe of the eye, which may be either flattened or elongated. In the former case (see *G*, Fig. 59), objects at a distance can be

Fig. 59.

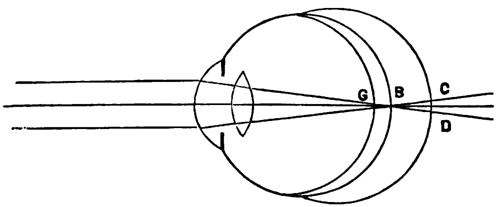


Diagram illustrating the position of the Retina.—B, *in natural sight;* G, *in far sight;* *and* C, *in near sight.*

seen most distinctly—hence that is called *far-sightedness* (*presbyopia*). In the latter, objects near by are clearer, and hence this is termed *near-sightedness*

(*myopia*). Far-sightedness is remedied by convex glasses; near-sightedness, by concave. When glasses will improve the sight they should be worn; any delay will be liable to injure the eyes, by straining their already impaired power. Cataract is a disease in which the crystalline lens becomes opaque and obscures the vision. A skilful surgeon can remove the lens, or cause it to be absorbed, after which convex glasses must be worn.

Color-Blind Persons receive only two of the three elementary color-sensations (green, red, violet). They are unable to distinguish between the leaves of a cherry-tree and its fruit by the color of the two, and see no difference between blue and yellow cloth. Whittier, the poet, it is said, cannot tell red from green unless in direct sunlight. Once he patched some damaged wall-paper in his library by matching a green vine in the pattern with one of a bright autumnal crimson. Persons are often color-blind without knowing it, and many railway accidents have doubtless happened through an inability to detect the color of the signal lights.

Care of the Eyes.—The shape of the eye cannot be changed by rubbing and pressing it, as many suppose, but the sight may thus be fatally injured. Children troubled by near-sightedness should not lean forward at their work, as thereby the vessels of the eye become overcharged with blood. They should avoid fine print, and try, in every possible way, to spare their eyes. Most cases of squinting are caused by long-sightedness, the muscles being strained in the effort to obtain distinct vision. In

childhood, it may be cured by a competent surgeon, who will generally cut the muscle that draws the eye out of place.

Even healthy eyes should never be used to read fine print or by a dim light. Serious injury may thus be caused. Reading upon the cars is also a fruitful source of harm, as the lens, forced to adapt itself to the incessantly-varying distance of the page, soon becomes wearied.

Objects that get into the eye should be removed before they cause inflammation; rubbing only irritates and increases the sensitiveness. If the eye be shut for a few moments, so as to let the tears accumulate, and the upper lid be then lifted by taking hold of it at the center, the cinder or dust is often washed away at once. Trifling objects can be removed by simply drawing the upper lid as far as possible over the lower one; when the lid flies back to its place, the friction will detach any light substance. If it becomes necessary, turn the upper lid over a pencil, and the intruder may then be wiped off with a handkerchief. "Eye-stones" are a popular delusion. When they seem to take out a cinder, it is only because they raise the eye-lid, and allow the tears to wash it out. No one should ever use an eye-wash, except by medical advice. The eye is too delicate an organ to be trifled with, and when any disease is suspected, a reliable physician should be consulted. This is especially necessary, since, when one eye is injured, the other, by sympathy, is liable to become inflamed, and perhaps be destroyed.

When reading or working, the *light should be at one side, and never in front.*

The constant increase of defective eyesight among the pupils in our schools is an alarming fact. Dr. Agnew remarks that our school-rooms are fast making us a spectacle-using people. Near-sightedness seems to increase from class to class, until, in the upper departments, there are sometimes as high as fifty per cent. of the pupils thus afflicted. The causes are (1), desks so placed as to make the light from the windows shine directly into the eyes of the scholars; (2), cross-lights from opposite windows; (3) insufficient light; (4), small type that strains the eyes; and (5), the position of the pupil as he bends over his desk or slate, causing his blood to settle in his eyes. All these causes can be remedied; the position of the desks can be changed; windows can be shaded, or new ones inserted; books and newspapers that try the eyes can be rejected; and every pupil can be taught how to sit at study.

PRACTICAL QUESTIONS.

1. Why does a laundress test the temperature of her flat iron by holding it near her cheek?
2. When we are cold, why do we spread the palms of our hands before the fire?
3. What is meant by a "furred tongue"?
4. Why has sand or sulphur no taste?
5. What was the origin of the world palatable?
6. How many rows of hairs are there in the eye-brows?
7. How often do we wink?

8. What is the object of the hairs in the nostrils?

9. What use does the nose subserve in the process of respiration?

10. Why do we sometimes hold the nose when we take unpleasant medicine?

11. Why was the nose placed over the mouth?

12. Describe how the hand is adapted to be the instrument of touch.

13. Besides being the organ of taste, what use does the tongue subserve?

14. Why is not the act of tasting complete until we swallow?

15. Why do all things have the same flavor when one's tongue is "furred" by fever?

16. Which sense is the more useful, hearing or sight?

17. Which coat is the white of the eye?

18. What makes the difference in the color of eyes?

19. Why do we snuff the air when we wish to obtain a distinct smell?

20. Why can an elderly person drink tea which to a child would be unbearably hot?

21. Why does an old man hold his paper so far from his eyes?

22. Would you rather be punished on the tips of your fingers than on the palm of your hand?

BLACKBOARD ANALYSIS.

THE SPECIAL SENSES.

- 1. The Touch............
  - 1. Description of the Organ.
  - 2. Its Uses.
- 2. The Taste............
  - 1. Description of the Organ.
  - 2. Its Uses.
- 3. The Smell............
  - 1. Description of the Organ.
  - 2. Its Uses.
- 4. The Hearing.........
  - 1. Description of the Organ.
    - a. External Ear.
    - b. Middle Ear.
    - c. Internal Ear.
  - 2. How we hear.
  - 3. Hygiene of the Ear.
- 5. The Sight............
  - 1. Description of the Organ.
  - 2. Eyelids and Tears.
  - 3. Structure of the Retina.
  - 4. How we see.
  - 5. The Use of the Crystalline Lens.
  - 6. Near, and Far Sight.
  - 7. Color-blindness.
  - 8. Hygiene of the Eyes.

CONCLUSION.

VALUE **of Health.**—The body is the instrument which the mind uses. If it be dulled or nicked, the effect of the best labor will be impaired. The grandest gifts of mind or fortune are comparatively valueless unless there be a healthy body to use and enjoy them. The beggar, sturdy and brave with his out-door life, is really happier than the rich man in his palace with the gout to twinge him amid his pleasures. The day has gone by when delicacy is considered an element of beauty. Weakness is timid and irresolute; strength is full of force and energy. Weakness walks or creeps; strength speeds the race, wins the goal, and rejoices in the victory.

False Ideas of Disease.—It was formerly supposed that diseases were caused by evil spirits, who entered the body and deranged its action. Incantations, spells, etc., were resorted to in order to drive them out. By others, disease was thought to come arbitrarily, or as a special visitation of an over-ruling power. Hence, it was to be removed by fasting and prayer. Modern science teaches us that disease is not a thing, but a state. When our food is properly assimilated, the waste matter promptly excreted, and all the organs work in harmony, we are well;

when any derangement of these functions occurs, we are sick. Sickness is discord, as health is concord. If we abuse or misuse any instrument, we impair its ability to produce a perfect harmony. A suffering body is simply the penalty of violated law.

Prevention of Disease.—Doubtless a large proportion of the ills which now afflict and rob us of so much time and pleasure might easily be avoided. A proper knowledge and observance of hygienic laws would greatly lessen the number of such diseases as consumption, catarrh, gout, rheumatism, dyspepsia, scrofula, etc. There are parts of England where one-half the children die before they are five years old. Every physiologist knows that at least nine-tenths of these lives could be saved by an observance of the simple laws of health. Professor Bennet, in a lecture at Edinburgh, estimated that 100,000 persons die annually in Great Britain from causes easily preventable.

With the advance of science, the causes of many diseases have been determined. Vaccination has been found to prevent or mitigate the ravages of small-pox. Scurvy, formerly so fatal among sailors that it was deemed "a mysterious infliction of Divine Justice against which man strives in vain," is now entirely avoided by the use of vegetables or lime-juice. Cholera, whose approach still strikes dread, and for which there is no known specific, is but the penalty for filthy streets, bad drainage, and over-crowded tenements, and may be controlled, if not prevented, by suitable sanitary measures. It was, no doubt, the intention that we should wear out

by the general decay of all the organs,* rather than by the giving out of any single part, and that all should work together harmoniously until the vital force is exhausted.

Cure of Disease.—The first step in the cure of any disease is to obey the law of health which has been violated. If medicine be taken, it is not to destroy the disease, since that is not a thing to be destroyed, but to hold the deranged action in check while nature repairs the injury, and again brings the system into harmonious movement. This tendency of nature is our chief reliance. The best physicians are coming to have diminished confidence in medicine itself, and to place greater dependence upon sanitary and hygienic measures, and the efforts which nature always makes to repair injuries and soothe disordered action. They endeavor only to give her a fair chance, and sometimes to assist her by the intelligent employment of proper medicines. The indiscriminate use of patent nostrums and sovereign remedies of whose constituents we know nothing, and by which powerful drugs are imbibed at haphazard, cannot be too greatly deprecated.† When

* "So long as the phenomena of waste and repair are in harmony—so long, in other words, as the builder follows the scavenger—so long man exists in integrity and repair—just, indeed, as houses exist. Derange nutrition, and at once degeneration, or rather let us say, alteration begins. Alas! that we are so ignorant that there are many things about our house, which, seeing them weaken, we know not how to strengthen. About the brick and the mortar, the frame and the rafters, we are not unlearned; but within are many complexities, many chinks and crannies, full in themselves of secondary chinks and crannies, and these so small, so deep, so recessed, that it happens every day that the destroyer settles himself in some place so obscure, that, while he kills, he laughs at defiance. You or I meet with an accident in our watch. We consult the watchmaker, and he repairs the injury. If we were all that watchmakers, like ourselves, should be, a man could be made to keep time until he died from old age or annihilating accident. This I firmly and fully believe." —*Odd Hours of a Physician.*

† A traveler in Africa states that he was surprised and delighted to find in the

one needs medicine, he needs also a competent physician to advise its use.

Death and Decay.—By a mystery we cannot understand, life is linked with death, and out of the decay of our bodies they, day by day, spring afresh. At last the vital force which has held death and decay in bondage, and compelled them to minister to our growth, and serve the needs of our life, faints and yields the struggle. These powers which have so long time been our servants, gather about our dying couch, and their last offices usher us into the new life and the grander possibilities of the world to come. This last birth, we who see the fading, not the dawning, life, call death.

> "O Father! grant Thy love divine,
> To make these mystic temples Thine,
> When wasting age and wearying strife
> Have sapp'd the leaning walls of life;
> When darkness gathers over all,
> And the last tottering pillars fall,
> Take the poor dust Thy mercy warms,
> And mold it into heavenly forms."
>
> *Holmes.*

possession of the chief medicine man of one of the interior tribes a carefully preserved copy of the New York *Tribune*. On inquiry, he found that it was exceedingly valuable, as a minute fragment of it either rubbed on the outside or taken inwardly was a sovereign remedy for as long a list of diseases as ever graced the advertisement of an American pain-killer. The mania which some people possess for tippling with patent medicines is no more sensible than the trust of the poor savage in a New York daily.

HINTS

ABOUT

THE SICK-ROOM.

A SICK-ROOM should be the lightest and cheeriest in the house. A small, close, dark bedroom or a recess is bad enough for one in health, but unendurable for a sick person. In a case of fever, and in many acute diseases, it should be remote from the noise of the family; but when one is recovering from an accident, and in all attacks where quiet is not needed, the patient may be where he can amuse himself by watching the movements of the household, or looking out upon the street.

The ventilation must be thorough. Bad air will poison the sick and the well alike. A fireplace is, therefore, desirable. Windows should open easily. By carefully protecting the patient with extra blankets, the room may be frequently aired. If there be no direct draught, much may be done to change the air, by simply swinging an outer door to and fro many times.

A bare floor, with strips of carpet here and there to deaden noise, is cleanest, and keeps the air freest from dust. Cane-bottomed chairs are preferable to upholstered ones. All unnecessary furniture should be removed out of the way. A straw bed or a mattress is better than feathers. The bed-hangings, lace curtains, etc., should be taken down. Creaking hinges should be oiled. Sperm candles are better than kerosene lamps.

Never whisper in a sick-room. All necessary conversation should be carried on in the usual tone of voice. Do not call a physician unnecessarily, but if one be employed *obey his directions* implicitly.

Never give nostrums over-officious friends may suggest. Do not allow visitors to see the patient, except it be necessary. Never bustle about the room, nor go on tip-toe, but move in a quiet, ordinary way. Do not keep the bottles in the continued sight of the sick person. Never let drinking-water stand in the room.

Do not raise the patient's head to drink, but have a cup with a long spout, or use a bent tube, or even a straw. Do not tempt the appetite when it craves no food. Bathe frequently, but let the physician prescribe the method. Give written directions to the watchers. Have all medicines carefully marked. Remove all soiled clothing, etc., at once from the room. Change the linen much oftener than in health. When you wish to change the sheets, and the patient is unable to rise, roll the under sheet tightly lengthwise to the middle of the bed ; put on the clean sheet, with half its width folded up, closely to the other roll ; lift the patient on to the newly-made part, remove the soiled sheet, and then spread out the clean one.

DISINFECTANTS.

An excellent disinfectant may be made by dissolving in a pail of water either of the following : (1), a quarter of a pound of sulphate of zinc and two ounces of common salt, for each gallon of water ; (2), a pound and a half of copperas, for each gallon of water. Towels, bed-linen, handkerchiefs, etc., should be soaked at least an hour, in a solution of the first kind, and then be boiled, before washing. Vaults, drains, vessels used in the sick-room, etc., should be disinfected by a solution of the second kind ; chloride of lime may also be used for the same purpose. Rooms, furniture, and articles that cannot be treated with the solution of the first kind, should be thoroughly fumigated with burning sulphur.

WHAT TO DO TILL THE DOCTOR COMES.

Burns.—When a person's clothes catch fire, quickly lay him on the ground, wrap him in a coat, mat, shawl, carpet, or in his own clothes, as best you can to extinguish the fire. Pour on plenty of water till the half-burned clothing is cooled. Then carry the sufferer to a warm

room, lay him on a table or a carpeted floor, and with a sharp knife or scissors remove his clothing.

The treatment of a burn consists in protecting from the air.* An excellent remedy is to apply soft cloths kept wet with sweet oil, or *cold water which contains all the "cooking soda" that it will dissolve.* Afterward dress the wound with carbolic acid salve. Wrap a dry bandage upon the outside. Then remove the patient to a bed and warmly cover.† Apply cold water to a small burn till the smart ceases, and then cover with ointment.. Do not remove the dressings until they become stiff and irritating; then take them from a part at a time; dress and cover again quickly.

Cuts, Wounds, etc.—The method of stopping the bleeding has been described on page 79. If an artery is severed, a physician should be called at once. If the bleeding is not profuse, apply cold water until it ceases, dry the skin, draw the edges of the wound together, and secure them by strips of adhesive plaster. Protect with an outer bandage. This dressing should remain for several days. In the meantime wet it frequently with cold water to subdue inflammation. When suppuration begins, wash occasionally with tepid water and Castile soap.

Dr. Woodbridge, of New York, in a recent address, gave the following directions as to "What to do in case of a sudden wound when the surgeon is not at hand." "An experienced person would naturally close the lips of the wound as quickly as possible, and apply a bandage. If the wound is bleeding freely, but no artery is spouting blood, the first thing to be done is to wash it with water at an ordinary temperature. To every pint of water add either five grains of corrosive sublimate, or two and a half teaspoonfuls of carbolic acid. If the acid is used, add two table-spoonfuls of glycerine, to prevent its irritating the wound. If there is neither of these articles in the house, add four table-spoonfuls of borax to the water. Wash the wound, close it, and apply a compress of a folded square of cotton or linen. Wet it in the

* It is a great mistake to suppose that salves will "draw out the fire" of a burn, or heal a bruise or cut. The vital force must unite the divided tissue by the deposit of material and the formation of new cells.

† If a burn be near a joint or on the face, even if small, let a doctor see it, and do not be in any hurry about having it healed. Remember that with all the care and skill which can be used, contractions will sometimes take place. The danger to life from a burn or scald is not in proportion to its severity, but to its extent—that is, a small part, such as a hand or a foot or a face, may be burned so deeply as to cripple it for life, and yet not much endanger the general health; but a slight amount of burning, a mere scorching, over two-thirds of the body, may prove fatal.—*Hope.*

solution used for washing the wound, and bandage down quickly and firmly. If the bleeding is profuse, a sponge dipped in very hot water and wrung out in a dry cloth should be applied as quickly as possible. If this is not available, use ice, or cloths wrung out in ice water. If a large vein or artery is spouting, it must be stopped at once by compression. This may be done by a rubber tube wound around the arm tightly above the elbow or above the knee, where the pulse is felt to beat; or an improvised 'tourniquet' may be used. A hard apple or a stone is placed in a folded handkerchief, and rolled firmly in place. This bandage is applied so that the hard object rests on the point where the artery beats, and is then tied loosely around the arm. A stick is thrust through the loose bandage and turned till the flow of blood ceases."

Bleeding from the Nose is rarely dangerous, and often beneficial. When it becomes necessary to stop it, sit upright and compress the nostrils between the thumb and forefinger, or with the thumb press upward upon the upper lip. A piece of ice, a snow-ball, or a compress wet with cold water may be applied to the back of the neck.

A Sprain is often more painful and dangerous than a dislocation. Wrap the injured part in flannels wrung out of hot water, and cover with a dry bandage, or, better, with oiled silk. Liniments and stimulating applications are injurious in the first stages, but useful when the inflammation is subdued. *Do not let the limb hang down.* It must be kept quiet, even after all pain has ceased. If used too quickly, dangerous consequences may ensue.

Diarrhea, Cholera Infantum, etc., are often caused by eating indigestible food or by checking of the perspiration; but more frequently by peculiar conditions of the atmosphere, especially in large cities. If the limbs are cold, give a hot bath, and rub thoroughly. *If possible, go to bed and lie quietly on the back. Rest is better than medicine.* If there be pain, apply repeatedly to the abdomen flannels wrung out of hot water. If medicine is needed, take fifteen drops of peppermint and thirty of paregoric in a wine-glass of warm water; or an adult may take twenty drops of spirits of camphor and thirty to forty drops of laudanum. Laudanum should rarely be given to an infant, except by a physician's order. Eat no fruit, vegetables, pastry, or pork. If much thirst exist, give small pieces of ice, or cold tea or toast-water.

Croup.—Send at once for a doctor. Induce vomiting by syrup of ipecac or mustard and water. Put the feet in a hot bath. Apply hot fomentations rapidly renewed to the chest and throat.

Sore Throat.—Wrap the neck in a wet bandage, and cover with red flannel or a woolen stocking. Gargle the throat frequently with a solution of a tea-spoonful of salt in a pint of water, or thirty grains of chlorate of potash in a wine-glass of water.

Fits, Apoplexy, Epilepsy, etc.—Loosen the clothing, and raise the head and shoulders, but do not bend the head forward on the neck. Apply cold to the head, and heat to the feet. Follow with an emetic. In a child, a full hot bath is excellent. When there are convulsions, prevent the patient from injuring himself; especially put something in his mouth to keep him from biting his tongue.

Toothache and Earache.—Insert in the hollow tooth, or in the ear, cotton wet with laudanum, spirits of camphor, or chloroform. When the nerve is exposed, wet it with creosote or carbolic acid. Hot cloths or a hot brick wrapped in cloth and held to the face will often relieve the toothache. In a similar manner treat the ear, wetting the cloth in hot water, and letting the vapor pass into the ear.

Choking.—Ordinarily a smart blow between the shoulders, causing a compression of the chest and a sudden expulsion of the air from the lungs, will throw out the substance. If the person can swallow, and the object be small, give plenty of bread or potato, and water to wash it down. Press upon the tongue with a spoon, when, perhaps, you may see the offending body, and draw it out with a blunt pair of scissors. If neither of these remedies avail, give an emetic of syrup of ipecac or mustard and warm water.

Frost Bites are frequently so sudden that one is not aware when they occur. In Canada it is not uncommon for persons meeting in the street to say, "Mind, sir, your nose looks whitish." The blood cools and runs slowly, and the blood-vessels become choked and swollen. *Keep from the heat.* Rub the part quickly with snow, if necessary for hours, till the natural color is restored. If one is benumbed with cold, take him into a cold room, remove the wet clothes, rub the body dry, cover with blankets, and give a little warm tea or weak brandy and water. On recovering, let him be brought to a fire gradually.*

Fevers, and many acute diseases, are often preceded by a loss of appetite, headache, shivering, "pains in the bones," indisposition to

* If you are caught in a snow-storm, look for a snow-bank in the lee of a hill, or a wood out of the wind, or a hollow in the plain filled with snow. Scrape out a hole big enough to creep into, and the drifting snow will keep you warm. Men and animals have been preserved after days of such imprisonment. Remember that if you give way to sleep in the open field, you will never awake.

work, etc. In such cases, sponge with tepid water, and rub the body till all aglow. Go to bed, place hot bricks to the feet, take nothing but a little gruel or beef tea, and drink moderately of warm, cream-of-tartar water. If you do not feel better the next morning, call a physician. If that be impossible, take a dose of castor-oil or Epsom salt.

Sun-stroke is a sudden prostration caused by intense heat. The same effect is produced by the burning rays of the sun and the fierce fire of a furnace. When a person falls under such circumstances, place your hand on his chest. If the skin be cool and moist, it is not a sun-stroke; but if it be dry and "biting hot," there can be no mistake. Time is now precious. At once carry the sufferer to the nearest pump or hydrant, and dash cold water on the head and chest until consciousness is restored.—*Dr. H. C. Wood.*

To prevent sun-stroke, wear a porous hat, and in the top of it place a wet handkerchief; also drink freely of water, not ice cold, to induce abundant perspiration.

Asphyxia, or apparent death, whether produced by drowning, suffocation, bad air, or coal gas, requires very similar treatment. Send at once for blankets, dry clothing, and a physician. Treat the sufferer upon the spot, if the weather be not too unfavorable.

1. Loosen the clothing about the neck and chest.

2. Turn the patient on his face, open the mouth, draw out the tongue, and cleanse the nostrils, so as to clear the air-passages.

3. Place the patient on his back, grasp his arms firmly above the elbows, and pull them gently upward until they meet over the head, in order to draw air into the lungs. Then bring the arms back by the side, to expel the air. Repeat the process about fifteen times per minute. Alternate pressure upon the chest, and blowing air into the mouth through a quill or with a pair of bellows, may aid your efforts. Excite the nostrils with snuff or smelling salts, or by passing hartshorn under the nose. Do not cease effort while there is hope. Life has been restored after five hours of suspended animation.

4. When respiration is established, wrap the patient in dry, warm clothes, and rub the limbs under the blankets or over the dry clothing energetically *toward the heart.* Apply heated flannels, bottles of hot water, etc., to the limbs, and mustard plasters* to the chest.

Foreign Bodies in the Ear.—Insects may be killed by dropping a little sweet oil into the ear. Beans, peas, matches, etc., may gener-

* The best mustard poultice is the paper plaster now sold by every druggist. It is always ready, and can be carried by a traveler. It has only to be dipped in water, and applied at once.

ally be removed by *cautiously* syringing the ear out with tepid water. Do not use much force lest the tympanum be injured. If this fail, dry the ear, stick the end of a little linen swab into thick glue, let the patient lie on one side, put this into the ear until it touches the substance, keep it there three-quarters of an hour while it hardens, and then draw them all out together. Be careful that the glue does not touch the skin at any point, and that you are at work upon the right ear. Children often deceive one as to the ear which is affected.

Foreign Bodies in the Nose, such as beans, cherry-pits, etc., may be frequently removed by closing the opposite nostril, and then blowing into the child's mouth forcibly. The air. unable to escape except through the other nostril, will sweep the obstruction before it.

ANTIDOTES TO POISONS.

Acids: *Nitric* (aqua fortis), *hydrochloric* (muriatic), *sulphuric* (oil of vitriol), *oxalic*, etc.—Drink a little water to weaken the acid, or, still better, take strong soap-suds. Stir some magnesia in water, and drink freely. If the magnesia be not at hand, use chalk, soda, lime, whiting, soap, or even knock a piece of plaster from the wall, and scraping off the white outside coat pound it fine, mix with milk or water, and drink at once. Follow with warm water, or flax-seed tea.

Alkalies: *Potash, soda, ley, ammonia* (hartshorn).—Drink weak vinegar or lemon juice. Follow with castor or linseed oil, or thick cream.

Antimony: *Antimonial Wine, tartar emetic*, etc.—Drink strong, green tea, and in the mean time chew the dry leaves. The direct antidote is a solution of nut-gall or oak-bark.

Arsenic: *Cobalt, Scheele's green, fly-powder, ratsbane*, etc.—Give *plenty of milk, whites of eggs*, or induce vomiting by mustard and warm water, or even soap-suds.

Bite of a Snake or a Mad Dog.—Tie a bandage above the wound, if on a limb. Wash the bite thoroughly, and, if possible, let the person suck it strongly. Rub some lunar caustic or potash in the wound, or heat the point of a small poker or a steel-sharpener white hot, and press it into the bite for a moment. It will scarcely cause pain, and will be effectual in arresting the absorption of the poison, unless a vein has been struck.

Copper: *Sulphate of copper* (blue vitriol), *acetate of copper* (verdigris). —Take whites of eggs or soda. Use milk freely.

Laudanum: *Opium, paregoric, soothing cordial, soothing syrup*, etc.—Give an emetic at once of syrup of ipecac, or mustard and warm water, etc. After vomiting, use strong coffee freely. *Keep the patient awake* by pinching, pulling the hair, walking about, dashing water in the face, and any expedient possible.

Lead: *White lead, acetate of lead* (sugar of lead), *red lead.* Give an emetic of syrup of ipecac, or mustard and warm water, or salt and water. Follow with a dose of Epsom salt.

Matches: *Phosphorus.*—Give magnesia, chalk, whiting, or even flour in water, and follow with mucilaginous drinks.

Mercury: *Calomel, chloride of mercury* (corrosive sublimate, bug poison), *red precipitate.*—Drink milk copiously. Take the whites of eggs, or even stir flour in water, and use freely.

Nitrate of Silver (lunar caustic).—Give salt and water, and follow with castor-oil.

Nitrate of Potash (saltpetre, nitre).—Give mustard and warm water, or syrup of ipecac. Follow with flour and water, and cream or sweet oil.

Prussic Acid (oil of bitter almonds), *cyanide of potassium*.—Take a tea-spoonful of hartshorn in a pint of water. Apply smelling salts to the nose, and dash cold water in the face.

Sting of an Insect.—Apply a little hartshorn or spirits of camphor, or soda moistened with water, or a paste of clean earth and saliva.

Sulphate of Iron (green vitriol).—Give syrup of ipecac, or mustard and warm water, or any convenient emetic; then magnesia and water.

QUESTIONS FOR CLASS USE.

The questions include the notes. The figures refer to the pages.

INTRODUCTION.

ILLUSTRATE the value of physiological knowledge. Why should physiology be studied in youth? When are our habits formed? How do habits help us? Why should children prize the lessons of experience. How does Nature punish a violation of her laws? Name some of Nature's laws. What is the penalty of their violation? Name some bad habits and their punishments. Some good habits and their rewards. How do the young ruin their health? Compare one's constitution with a deposit in the bank. Can one in youth lay up health as he can money for middle or old age? Is not the preservation of one's health a moral duty? What is suicide?

THE SKELETON.

How many bones are there in the body? Is the number fixed? What is an organ? (See Glossary.) A function? Name the three uses of the bones. Why do the bones have such different shapes? Why are certain bones hollow? Round? Illustrate. Why are iron pillars in stores cast hollow? What is the composition of bone? How does it vary?

12. How can you remove the mineral matter? The animal matter? Why is a burned bone white and porous? What is the use of each of the constituents of a bone? What food do dogs find in bones? What is ossification? Why are not the bones of children as easily broken as those of aged persons? Why do they unite so much

quicker? Describe the structure of a bone. What is the object of the filling? Why does the amount vary in different parts of a bone?

13. What is the appearance of a bone seen through a microscope? How do bones grow? Illustrate. How does a broken bone heal? How rapidly is bone produced? Illustrate. What is the object of "splints"? Describe how a joint is packed. Lubricated. How are the bones tied together? What is a tissue? (See Glossary.) Illustrate.

14. Name the three general divisions of the bones. What is the object of the skull? Which bone is movable? How is the lower jaw hinged? Describe the construction of the skull. What is a suture?

15. Tell how the peculiar form and structure of the skull adapt it for its use. What two cavities are in the trunk? Name its principal bones. Describe the spine. What is the object of the projections? Of the pads? Why is a man shorter at night than in the morning?

16. Describe the perfection of the spine. The articulation (see Glossary) of the skull with the spine.

17. Describe the ribs. What is the natural form of the chest? Why is the thorax, or chest, made in separate pieces? How does the oblique position of the ribs aid in respiration? (See p. 53.)

18. How do the hip-bones give solidity? What two sets of limbs branch from the trunk? State their mutual resemblance.

19. Name the bones of the shoulder. Describe the collar-bone. The shoulder-blade. Name the bones of the arm. Describe the shoulder-joint. The elbow joint. The wrist.

20. Name the bones of the hand (see p. 24). The fingers. Describe their articulations. What gives the thumb its freedom of motion? In what lies the perfection of the hand?

21. Describe the hip-joint. What gives the upper limbs more freedom of motion than the lower? Name the bones of the lower limbs. Describe the knee-joint. The patella. What is the use of the fibula? Can you show how the lower extremity of the fibula, below its juncture with the tibia, is prolonged to form a part of the ankle-joint?

22. Name the bones of the foot. What is the use of the arch of the foot? What makes the step elastic? Describe the action of the foot as we step. In graceful walking should the toes or the heel touch the ground first? What are the causes of deformed feet? What is the natural position of the big toe? Did you ever see a big toe lying in a

straight line with the foot, as shown in statuary and paintings? How should we have our boots and shoes made? What are the effects of high heels? Of narrow heels? Of narrow toes? Of tight-laced boots? Of thin soles? What are the rickets? Cause of this disease? Cure? Cause of bow-legs? Cure?

23. What is the correct position in sitting at one's desk? Is there any necessity for walking and sitting erect? Describe the bad effects of a stooping position. What is a sprain? Why does it need special care? What is a dislocation? (See Glossary.)

THE MUSCLES.

25. WHAT is the use of the skeleton? How is it concealed? Why is it the image of death? What are the muscles? How many are there? What peculiar property have they? How are they arranged? Where is the biceps? The triceps? How do the muscles move the limbs? Illustrate.

26. Name and define the two kinds of muscles. Illustrate each. What is the structure of a muscle? Of what is a fibril itself composed?

27–8. Describe the tendons. What is their use? Illustrate the advantages of this mode of attachment. What two special arrangements of the tendons in the hand? Their use? How is the rotary motion of the eye obtained?

29. What advantages are gained by the enlargement of the bones at the joints? Illustrate. How do we stand erect? Is it an involuntary act? Why cannot a child walk at once, as many young animals do? Why can we not hold up the head easily when we walk on "all fours"? Why cannot an animal stand erect as man does?

30. Describe the process of walking. Show that walking is a process of falling. Describe the process of running. What causes the swinging of the hand in walking? Why are we shorter when walking? Why does a person when lost often go in a circle? In which direction does one always turn in that case? What is the muscular sense? Its value?

31–2. Value of exercise? Is there any danger of violent exercise? For what purpose should we exercise? Should exercise be in the open air? What is the Law of Health in regard to exercise? Is a young person excusable, who leads a sedentary life, and yet takes no daily out-door exercise? What will be nature's penalty for such a violation of her law? Will a postponement of the penalty show that we have escaped it? Ought a scholar to study during the time of recess? Will a promenade in the vitiated air of the school-room furnish suitable exercise? What is the best time for taking exercise? Who can exercise before breakfast? What are the advantages of the different kinds of exercise? Should we not walk more? What is the general influence upon the body of vigorous exercise? State some of the wonders of the muscles.

33. What is the St. Vitus's dance? Cure? What is the locked-jaw? Causes? The gout? Cause? Cure? The rheumatism? Its two forms? Peculiarity of the acute? Danger? Is there any particular mode of treating it?

THE SKIN.

35. WHAT are the uses of the skin? Describe its adaptation to its place. What is its function as an organ? Describe the structure of the skin. The sensitiveness of the cutis. The insensitiveness of the cuticle.

46. How is the skin constantly changing? The shape and number of the cells? Value of the cuticle? How is the cuticle formed? What is the complexion? Its cause? Why is a scar white? What is the cause of "tanning"? What are freckles? Describe the action of the sun on the skin. Why are hairs and the nails spoken of under the head of the skin?

37. Uses of the hair? Its structure? What is the hair-bulb? What is it called? How does a hair grow? When can it be restored, if destroyed? What is the danger of hair-dyes? Are they of any real value? How can the hair stand on end? How do horses move their skin? Is there any feeling in a hair? What are the uses of the nails?

38. How do the nails grow? What is the mucous membrane? Its composition? The connective tissue? Why so called? What use does it subserve? What is its character?

39. Name some of the many uses of the membranes in the body. How does the fat exist in the body? Its uses? Where is there no fat? Name and describe the four kinds of teeth. What are the milk teeth? Describe them.

41. What teeth appear first? When do the permanent teeth appear? Describe their growth. Which one comes first? Last? Describe the structure of the teeth.

42. Why do the teeth decay? What care should be taken of the teeth? What caution should be observed? What are the oil glands? Use of this secretion?

43. What are the perspiratory glands? State their number. Their total length. What are the "pores" of the skin? What is the perspiration? What is the constitution of the perspiration? Illustrate its value. Why do we need to bathe so often?

44. When is the best time for a bath? Why? Value of friction? Should a bath be taken just before or after a meal? Is soap beneficial? What is the "reaction"? Explain its invigorating influence. How is it secured? General effect of a cold bath? Of a warm bath? If we feel chilly and depressed after a bath, what is the teaching?

45. Why is the sea-bath so stimulating? How long should one remain in any bath? How does clothing keep us warm? Explain the use of linen as an article of clothing. Cotton. Woolen. Flannel. How can we best protect ourselves against the changes of our climate?

46–7. What colored clothing is best adapted for all seasons? Value of the nap? Furs? Thick *vs.* thin clothing? Should we wear thick clothing during the day, and in the evening put on thin clothing? Can children endure exposure better than grown persons? What are corns? What is the cause? Cure? What are in-growing nails? What is the cure? Warts? Cure? Chilblain? Cause? Preventive?

RESPIRATION AND THE VOICE

49. NAME the organs of respiration and the voice. Describe the larynx. The epiglottis. The œsophagus. What is meant by food "going the wrong way"?

50. Describe the vocal cords. Their use. How is sound produced?

51. How are the higher tones of the voice produced? The lower? Upon what does loudness depend?

52. What is the cause of the voice "changing"? What is speech? Vocalization? Could a person talk without his tongue? How is *a* formed by the voice? Difference between a sigh and a groan? What vowel sounds are made in laughing? Does whistling depend on the voice? Tell how the various consonants are formed. What are the labials? The dentals? The linguals? What vowels does a child pronounce first?

53. Describe the wind-pipe. The bronchi. The bronchial tubes. Why is the trachea so called? Describe the structure of the lungs. What are the lungs of slaughtered animals called? Why will a piece of the lungs float on water? Name the wrappings of the lungs. Describe the pleura. How is friction prevented? What are the cilia? What is their use? What two acts constitute respiration?

54. In what two ways may the position of the ribs change the capacity of the chest? Describe the process of respiration. Expiration.

55. How often do we breathe? Describe the diaphragm. Its use in breathing. What is coughing? Sneezing? Snoring? Laughing? Crying? Hiccough? What is meant by the breathing capacity? How does it vary? How much, in addition, can the lungs expel forcibly? Can we expel all the air from our lungs? Value of this constant supply?

56. How constant is the need of air? What is the vital element of the air? Describe the action of the oxygen in our lungs. What does the blood give up? Gain? How can this be tested? What are the constituents of the air? What are the peculiar properties and uses of each? What is the condition of the air we exhale? Which is the most dangerous constituent?

57–63. Describe the evil effects of re-breathing the air. Give illustrations of the dangers of bad air. What is meant by the germs of disease floating in the air? Describe the need of ventilation. Will a single breath pollute the air? What is the influence of a fire or a light? Of a hot stove? When is the ventilation perfect? What diseases are largely owing to bad air? Should the windows and doors of any room be tightly closed, if we have no other means of ventilation? Is not a draught of air dangerous? How can we prevent this, and yet secure fresh air? What is the general principle of ventilation? Must pure air necessarily be cold air? Are school-rooms properly ventilated? What is the effect? Are churches? Are our bed-rooms? Can we, at night, breathe anything but night air? Is the night air out-of-doors ever injurious?

63–5. Describe some of the wonders of respiration. How is constriction of the lungs produced? When may clothing be considered tight? What are the dangers of tight-lacing? Which would make the stronger, more vigorous, and longer-lived person, the form shown in *A* or *B*, Fig. 28? Is it safe to run any risk in this dangerous direction? What is the bronchitis? Pleurisy? Pneumonia? Consumption? What is one great cause of this disease? How may a constitutional tendency to this disease be warded off in youth? What is asphyxia? Describe the process for restoring such a person. (See *Appendix*.) What is the diphtheria? Its peculiarity? Danger?

66. The croup? Its characteristics? Remedy? (See *Appendix*.) Cause of stammering? How cured?

THE CIRCULATION.

67. Name the organs of the circulation. Does the blood permeate all parts of the body? What is the average amount in each person? Its composition?

68. What is the plasma? Describe the red cells (corpuscles). The white. What is the size of a red cell? Are the shape and size uniform? Are the disks permanent? What substances are contained

in the plasma? What is fibrin? In what sense is the blood "liquid flesh"? What is the use of the red disks? What is the office of the oxygen in the body? Where is the blood purified?

69. What is the cause of coagulation of the blood? Value of this property? What organ propels the blood?

70. What is the location of the heart? How large is it? Put your hand over it. What is the pericardium? How many chambers in the heart?

71. What is their average size? What is meant by the right and the left heart? What are the auricles? Why so called? The ventricles? What is the use of the auricles? The ventricles? Which are made the stronger? Show the need of valves in the ventricles. Why are there no valves in the auricles?

72. Describe the tricuspid valve. The bicuspid. Describe the semilunar valves. What are the arteries? Why so named? What is their use? Their structure? How does their elasticity act? What is the aorta? What is the pulse?

73. On which arteries can we best feel it? What is the average number of beats per minute? How and why does this vary? Why does a physician feel a patient's pulse? What are the veins? What blood do they carry? Describe the venous system. Describe the valves of the veins. Which valves of the heart do they resemble? Where and how can we see the operation of these valves? What are the capillaries?

74. What is the function of the capillaries? What changes take place in this system? Describe the circulation of the blood as seen in the web of a frog's foot. In what two portions is the general circulation divided?

75. Describe the route of the blood by the diagram. 1. The lesser circulation; 2. The greater circulation.

76. How long does it require for all the blood to pass through the heart? How long does it take the blood to make the tour of the body? What is the average temperature of the body? How and where is the heat of the body generated? How is it distributed? How is the temperature of the body regulated? In what way does life exist through death?

77. Is not this as true in the moral as in the physical world? What

does it teach? How rapidly do our bodies change? Name some of the wonders of the heart.

78. What is the lymphatic circulation? What is the thoracic duct? The lymph? The glands?

79. Give some illustrations of the action of the lymphatics of the different organs. How do hibernating animals live during the winter? What is a congestion? Its cause? Blushing? Why does terror cause one to grow cold and pale? How is an inflammation caused? Name its four characteristics. How may severe bleeding be stopped? How can you tell whether the blood comes from an artery or a vein?

80. What is the scrofula? What are "kernels"? How may a scrofulous tendency of the system be counteracted? What is the cause of "a cold"? Why does exposure sometimes cause a cold in the head, sometimes on the lungs, and at others brings on a rheumatic attack? What is the theory of treating a cold?

81–2. How is alcohol always made? Does it exist in nature? Describe the general process of fermentation. What is "malt"? How is beer made? What is distillation? How is whisky manufactured?

83. Illustrate some of the properties of alcohol. Illustrate the general effect of alcohol upon the circulation.

84–9. Upon the heart. Upon the membrane. Upon the blood. Upon the lungs. When does it cause consumption? What is meant by a "fatty degeneration" of the heart? How does alcohol check the regular process of oxidation, or waste and repair of the body?

DIGESTION AND FOOD.

91. WHY do we need food? Why will a person starve without food? How much food is needed per day by an adult in active exercise? How much in a year? Describe the body as an eddy. What does food do for us? What does food contain? How is this force set free? Do we then draw all our power from nature? What becomes of these forces when we are done with them? Do we destroy the force we use? *Ans.* No matter has been destroyed, so far as we know, since the creation, and force is equally indestructible.

92. Compare our food to a tense spring. What three kinds of food do we need? What is nitrogenous food? Name the common forms. What is the characteristic of nitrogenous food? Why called albuminous? What is carbonaceous food? Name the two kinds. What are the constituents of sugar? Where is starch ranked? Why? Use of carbonaceous food?

93. Name the mineral matters which should be contained in our food. What do you say of the abundance and necessity of water? Ought we not to exercise great care in selecting the water we drink?* Will not the character of our food influence the quantity of water we need? What are the uses of these different minerals? Illustrate from your own knowledge the importance of salt. Could a person live on one kind of food alone? Illustrate. Describe the effect of living on lean meat. Show the necessity of a mixed diet. Illustrate. Show the need of digestion. Illustrate.

94. Describe the general plan of digestion. What amount of liquid is daily secreted by the alimentary canal? What is the alimentary canal? How is it lined? Define secretion. Describe the saliva.

95. How is it secreted? What is the amount per day? Its use? What tends to check or increase the flow of saliva? Describe the process of swallowing. The stomach. Its size.

96. Its construction. What is the pylorus? For what does this open? What is the gastric juice? How abundant is it? What principle does it contain? How is its flow influenced? What is its use? Appearance of the food as it passes through the pylorus? What is the construction of the intestines?

98. How are the intestines divided? What is the duodenum? Why so called? What juices are secreted here? What is the bile? Describe the liver. What is its weight? Its construction? *Ans.* It

* Water which has passed through lead-pipes is apt to contain salts of that metal, and is therefore open to suspicion. Metallic-lined ice-pitchers, galvanized-iron reservoirs, and many soda-water fountains, are liable to the same objection. There are also organic impurities in water equally dangerous. River-water often disseminates the germs of typhoid fever and other diseases just as the air scatters the seeds of small-pox and scarlet fever. Thus the great outbreak of cholera in the east of London, in 1866, was traced to the contamination of the River Lea, which furnished the supply of water to that part of the city. The surface water frequently flows into a well carrying organic matter to poison its contents. Wells sometimes receive underground the drainage from grave-yards, manufactories, cess-pools, swamps, barn-yards, vaults, etc., all of which render the water unfit for use.

consists of a mass of polyhedral cells only $\frac{1}{100}$ to $\frac{1}{2000}$ of an inch in diameter, filling a mesh of capillaries. The capillaries carry the blood to and fro, and the cells secrete the bile. What is the cyst? What does the liver secrete from the blood besides the bile? What is its use? What is the pancreatic juice? Its use?

99. Appearance of the food when it leaves the duodenum? Describe the small intestine. What is absorption?

100. In what two ways is the food absorbed? Where does the process commence? How long does it last? Describe the lacteals. Of what system do they form a part? What do the veins absorb? Where do they carry the food? How is it modified? What length of time is usually required for digestion in the stomach? May not food which requires little time in the stomach need more in the other organs, and *vice versa?* Tell the story of Alexis St. Martin.

101. What time did he require to digest apples? Eggs, raw and cooked? Roast beef? Pork? Which is the king of the meats? What is the nutritive value of mutton? Lamb? How should it be cooked? Objection to pork? What is the trichina? Should ham ever be eaten raw? Value of fish? Oysters? Milk? Cheese? Eggs?

102. Bread? Brown bread? Are warm biscuit and bread healthful? Nutritive value of corn? The potato? Of ripe fruits? Of coffee? To what is its stimulating property due? Its influence on the system? When should it be discarded?

103. Effects of tea? Influence of strong tea? What is the active principle of tea? What is the effect of cooking food? What precaution in boiling meat? In roasting? Object of this high temperature? What precaution in making soup? Why is frying an unhealthful mode of cooking? State the five evil results of rapid eating. What disease grows out of it? If one is compelled to eat a meal rapidly, as at a railroad station, what should he take?

104. Why does a child need more food proportionately than an old person? State the relation of waste to repair in youth, in middle, and in old age. What kind and quantity of food does a sedentary occupation require? What caution should students who have been accustomed to manual labor observe? Must a student starve himself? Is there not danger of over-eating? Would not an occasional abstinence from a meal be beneficial? Do not most people eat more than is for

their good? How should the season regulate our diet? The climate? Illustrate. What is the effect upon the circulation of taking food? Should we labor or study just before or after a meal? Why not? What time should intervene between our meals? Is "lunching" a healthful practice? Should we eat just before retiring? When we are very tired?

105. Why should care be banished from the table? Will a regular routine of food be beneficial? Describe some of the wonders of digestion.

106. What are the principal causes of dyspepsia? How may we avoid that disease? What are the mumps? What care should be taken?

107–113. Is alcohol a food? Illustrate. Compare the action of alcohol with that of water. Does all the alcohol taken into the stomach go off unchanged? Does alcohol contain any element needed by the body? What is the effect of alcohol upon the digestion? Upon the pepsin of the gastric juice? Upon the albuminous food? What is a "fatty degeneration of the kidneys"? Will alcohol help one to endure cold and exposure? Will liquor strengthen the muscles of a working man? Is alcohol digested? Is liquor a wholesome "tonic"? Is it a good plan to take a glass of liquor before dinner? What is the effect of alcohol upon the liver? What is the "Hob-nail" liver? What is the general effect of alcohol upon the kidneys? Does alcohol impart heat to the body? Does it confer strength? What does Dr. Kane say? Describe Richardson's experiments. How does alcohol act in creating an appetite for itself? What is alcoholism? What is heredity?

THE NERVOUS SYSTEM.

115. WHAT are the organs of the nervous system? What is the general use of this system? What is the gray matter? Its use? The white matter? Its use? Describe the brain. What is its office? Its size? How does it vary?

117. Name its two divisions. Describe the cerebrum. The convo-

lutions. The membranes which bind the brain together. What do you say of the quantity of blood which goes to the brain? What does it show? What do the convolutions indicate? What is the use of the two halves of the brain?

118. What is the effect of removing the cerebrum? Describe the cerebellum.

119. What is the arbor vitæ? What does this part of the brain control? What is the effect of its being injured? Illustrate. Describe the spinal cord. What is the medulla oblongata? Describe the nerves. Is each part of the body supplied with its own nerve?

120–3. Prove it. What are the motory nerves? The sensory? When will motion be lost and feeling remain, and *vice versa?* What is meant by a transfer of pain? Illustrate. Name the three classes of nerves. What are the spinal nerves? Describe the origin of the spinal nerve. What is the effect of cutting a sensory root? A motory root? What are the cranial nerves? Name the twelve pairs. Describe the sympathetic system. What is its use? How does the brain control all the vital processes? What is meant by the crossing of the cords? What is the effect? What is reflex action?

124. Give illustrations. Give instances of the unconscious action of the brain. Can there be feeling or motion in the lower limbs when the spinal cord is destroyed? What are the uses of reflex action? State its value in the formation of habits. How does the brain grow?

125. What laws govern it? What must be the effect of constant light-reading? Of over-study or mental labor? State the relation of sleep to repair and waste. How many hours does each person need? What kind of work requires most sleep? What danger is there in obtaining sleep by medicine? What is the influence of sunlight on the body?

126. Illustrate. Name some of the wonders of the brain.

127–131. What four stages are there in the effect of alcohol on the nervous system? Describe each. Does alcohol confer any permanent strength? What is the physiological effect of alcohol on the brain? On the mental and moral powers? What is the Delirium Tremens? Do you think a man should be punished for a crime he commits while drunk? How does alcohol interfere with the action of the nerves? What is the general effect of alcohol upon the character? Does alcohol

tend to produce clearness and vigor of thought? What is the cause of the "alcoholic chill"? Show how alcohol tends to develop man's lower, rather than his higher, nature. When we wish really to strengthen the brain, should we use alcohol? Why is alcohol used to preserve anatomical specimens? What is meant by an inherited taste for liquor? To what extent are we responsible for the health of our body? Why does alcohol tend to collect in the brain? Does the use of alcohol tend to increase crime, and poverty?

132–4. What are the principal constituents of tobacco? What are the physiological effects of tobacco? Who are most likely to escape injury? Is tobacco a food? What is its influence upon youth? Why are cigarettes specially injurious? Name illustrations of the injurious effect of tobacco on young men.

135–6. How is opium obtained? What is its physiological effect? Can one give up the use of opium when he pleases? What is the danger in its use?

136–7. What is the harmful influence of chloral hydrate? Of chloroform?

THE SPECIAL SENSES.

139. NAME the five senses. To what organ do all the senses minister? If the nerve leading to any organ of sense be cut, what would be the effect? Sometimes persons lose feeling in a limb, but retain motion; why is this? What is the sense of touch sometimes called? Describe the organ of touch. What are the papillæ? Where are they most abundant? What are the uses of this sense? What special knowledge do we obtain by it? Why do we always desire to handle anything curious?

140. Can the sense of touch always be relied upon? Illustrate. Tell how one sense can take the place of another. Give illustrations of the delicacy of touch possessed by the blind.

141. Describe the sense of taste. How can you see the papillæ of taste? What causes the velvety look of the tongue? Why do salt and bitter flavors induce vomiting? Why does an acid "pucker" the face? What substances are tasteless? Illustrate. Has sulphur any

taste? Chalk? Sand? What is the use of this sense? Does it not also add to the pleasures of life? Why are the acts of eating, drinking, etc., thus made sources of happiness?

142. Describe the organ of smell. Must the object to be smelled touch the nose? What are the uses of this sense? Are agreeable odors healthful, and disagreeable ones unhealthful?

143. Describe the organ of hearing. Describe the external ear. What is the tympanum or drum of the ear? Describe the middle ear. Name the bones of the ear. Describe their structure. Describe the internal ear. By what other name is it known? What substances float in the liquid which fills the labyrinth? Describe the fibers of Corti. What do they form? How are the vibrations of the air modified before they reach the nerve? Give the theory of sound. What advice is given concerning the care of the ear? How can insects be removed?

145. Describe the eye. Name the three coats of which it is composed. What is the object of the crystalline lens? Describe the liquids which fill the eye. What is the pupil? Describe the eyelids. Why is the inner side of the eyelid so sensitive? What is the use of the eyelashes? Where are the oil glands located? What is their use? Describe the lachrymal gland. The lachrymal lake. What causes the overflow in old age? Explain the use of the rods and cones. What is the blind spot? Illustrate. What is the theory of sight? Illustrate. State the action of the crystalline lens. Its power of adaptation. Cause of near-sightedness. How remedied? Cause of far-sightedness? How remedied? Do children ever need spectacles? What is the cataract? How cured? What care should be taken of the eyes? Should one constantly lean forward over his book or work? What special care should near-sighted children take? By what carelessness may we impair our sight? Should we ever read or write at twilight? What is the danger of reading upon the cars? What course should we take when objects get into the eye? How may they be removed? Are "eye-stones" useful? Why we should never use eye-washes except upon the advice of a competent physician? What care should be taken with regard to the direction of the light when we are at work?

GLOSSARY.

AB DO'MEN (*abdo*, I conceal). The largest cavity in the body, in which are hidden the intestines, stomach, etc.

AB SORB'ENT (*ab*, from; *sorbeo*, I suck up).

AC'E TAB'U LUM (*acetum*, vinegar). The socket for holding the head of the thigh-bone, shaped like an ancient vinegar vessel.

A CET'IC (*acetum*, vinegar).

AD'I POSE. Fatty.

AL BU'MEN (*albus*, white). A substance resembling the white of egg.

AL BU'MI NOUS substances contain much albumen.

AL'I MENT'A RY. Pertaining to food.

AL'KA LINE (-lĭn) substances neutralize acids.

AN'ÆS THET'IC. A substance that destroys the feeling of pain.

A OR'TA. The largest artery of the body.

AP'O PLEX Y (-plek-se). A disease marked by loss of sensation and voluntary motion.

A'QUE OUS (ā'-kwe-us). Watery.

A RACH'NOID (*arachne*, a spider; *eidos*, form). A membrane like a spider's web covering the brain.

AR'BOR VI'TÆ means "the tree of life."

AR'TER Y (*aer*, air; *tereo*, I contain). So named because after death the arteries contain air only, and hence the ancients supposed them to be air-tubes leading through the body.

AR TIC'U LATE (*articulo*, I form a joint). AR TIC'U LA TION. A joint.

AS PHYX'I A (-fix'-ē-a). Literally, no-pulse; apparent death.

AS SIM'I LA'TION is the process of changing food into flesh, etc.

AT'LAS. So called because, as in ancient fable the god Atlas supported the globe on his shoulders, so in the body this bone bears the head.

AU'DI TO RY NERVE. The nerve of hearing.

AU'RI CLE (*auris*, ear) of the heart. So named from its shape.

BI'CEPS. A muscle with two heads, or origins.

BI CUS'PID. Tooth with two points; also a valve of the heart.

BRON'CHI (-kī). The two branches of the wind-pipe.

BRON'CHI AL TUBES. Subdivisions of bronchi.

BUR SA (a purse). Small sac containing fluid near a joint.

CA NINE′ (*canis*, a dog) teeth are like dogs' teeth.

CAP′IL LA RIES (*capillus*, a hair). A system of tiny blood-vessels.

CAR′BON. Pure charcoal.

CAR BON′IC ACID. A deadly gas given off by the lungs, and by fires.

CA ROT′IDS (*karos*, lethargy). Arteries of the neck, so named because the ancients supposed them to be the seat of sleep.

CAR′PUS. The wrist.

CAR′TI LAGE. Gristle.

CELL. A minute sac, usually with soft walls and fluid contents.

CEL′LU LAR (*cellula*, a little cell). Full of cells.

CER′E BEL′LUM. The little brain.

CER′E BRUM. A Latin word meaning brain.

CER′VI CAL. Relating to the neck.

CHLO′RAL (klō) HY′DRATE. A drug used to induce sleep.

CHO′ROID. The second coat of the eye.

CHYLE (kīle). A milky juice formed in digestion.

CHYME (kīme). From *chumos*, juice.

CIR′CU LA′TION. The course of the blood through the body.

CIL′I A (the plural of *cilium*, an eyelash). Hair-like projections in the air-passages.

CLAV′I CLE (klăv-i-kl). From *clavis*, a key.

CO AG′U LA′TION. A clotting of blood.

COC′CYX (a cuckoo). A bony mass below the sacrum.

COCH′LE A. A Latin word meaning snail shell. See Ear.

COM′POUND. A substance composed of two or more elements.

CON TA′GI OUS diseases are those caught by contact, the breath, etc.

CON′TRAC TIL′I TY (*con*, together; *traho*, I draw).

CON′VO LU′TION (*con*, together; *volvo*, I roll).

COR′NE A (*cornu*, a horn). A transparent, horn-like window in the eye.

COR′PUS CLE (kor′-pus-l). From a Latin word meaning a little body. It is applied to the disks of the blood.

CRA′NI AL. Relating to the skull.

CRYS′TAL LINE (*crystallum*, a crystal).

CU TA′NE OUS (*cutis*, skin). Pertaining to the skin.

CU′TI CLE (kū′ti kl). From a Latin word meaning little skin.

CU′TIS, the true skin.

DEN′TAL (*dens*, *dentis*, a tooth).

DI′A PHRAGM (-frăm). The muscle dividing the abdomen from the chest.

DI AS′TO LE (*diastello*, I put asunder). Dilation of the heart.

DIS′LO CA′TION. A putting out of joint.

DOR′SAL (*dorsum*, the back).

DUCT. A small tube.

DU O DE′NUM (*duodeni*, twelve each).

DU'RA MA'TER (*durus*, hard ; *mater*, mother). The outer membrane of the brain.

DYS PEP'SI A is a difficulty of digestion.

E LIM'I NATE. To expel.

EP'I DEM'IC. A disease affecting a great number of persons at once.

EP'I DERM'IS. The cuticle.

EP'I GLOT'TIS (*epi*, upon ; *glōttis*, the tongue). The lid of the wind-pipe.

EP'I THE'LI UM. The outer surface of mucous or serous membranes.

EU STA'CHI AN (yu-sta'ki-an) TUBE. So named from its discoverer, an Italian physician.

EX CRE'TION. Waste particles thrown off by the excretory organs.

FER'MEN TA'TION. The process by which sugar is turned into alcohol.

FI'BRIN (*fibra*, a fiber).

FIL'A MENT (*filum*, a thread).

FUNC'TION. See Organ.

GAN'GLI ON (gang'-gli-on). From *ganglion*, a knot ; plu. ganglia.

GAS'TRIC (*gaster*, stomach).

GLANDS (glăndz). From *glans*, a Latin word meaning acorn. Their object is to secrete in their cells some liquid from the blood.

GLOT'TIS. The opening at the top of the larynx.

HU'ME RUS. The arm-bone.

HU'MOR. A Latin word meaning moisture.

HY'DRO GEN. The lightest gas known, and one of the elements of water.

HY'GI ENE. From a Greek word meaning health.

HYP'O GLOS'SAL. Literally "under the tongue"; a nerve of the tongue.

IN CI'SOR (*incido*, I cut) teeth are cutting teeth.

IN'SPI RA'TION (*in* and *spiro*, I breathe in).

IN TES'TINE (-tĭn). From *intus*, within.

LACH'RY MAL (*lachryma*, a tear). Pertaining to tears.

LAC'TE AL (*lac*, *lactis*, milk). So called from the milky look of the chyle during digestion.

LA CU'NA, plu. lacunæ (*lakos*, a hole). Cavities in the bone-structure.

LAR'YNX (lăr-ĭnx). The upper part of the wind-pipe.

LIG'A MENTS (*ligo*, I bind) tie bones together.

LU'BRI CATE. To oil in order to prevent friction.

LUM'BAR (*lumbus*, a loin). Pertaining to the loins.

LYMPH (lĭmf). From *lympha*, pure water.

LYM PHAT'IC (lim-fat'-ik).

MAS'TI CA'TION. The act of chewing.

ME DUL'LA OB LON GA'TA. The upper part of the spinal cord.

MEM'BRANE. A thin skin, or tissue.

MES'EN TER Y. The membrane by which the intestines are fastened to the spine.

MET'A CAR'PAL (*meta*, after; *karpos*, wrist).

MET'A TAR'SAL (*meta*, after; *tarsos*, the instep).

MI'CRO SCOPE (*mikros*, small; *skopeo*, I see).

MO'LAR (*mola*, a mill) teeth are the grinders.

MOR'PHINE (*Morpheus*, the Greek god of sleep).

MO'TO RY. Giving motion.

MU'COUS (-kus) MEMBRANE. A thin tissue, or skin, covering the open cavities of the body. See Serous.

MU'CUS. A fluid secreted by a membrane and serving to lubricate it.

MUS'CLE (mŭs'sl). A bundle of fibers covered by a membrane.

MY O'PIA (*muo*, I contract; *ops*, the eye).

NAR COT'IC. A drug producing sleep.

NA'SAL (na'-zle). From *nasus*, the nose.

NERVE (*neuron*, a cord).

NI'TRO GEN GAS is the passive element of the air.

NI TROG'E NOUS. Containing nitrogen.

NU TRI'TION. The process by which the body is nourished.

Œ SOPH'A GUS (ē-sŏf'-a-gŭs). The gullet; literally, a "food-carrier."

OL FAC'TO RY. Pertaining to the smell.

OR'GAN. An organ is a portion of the body designed for a particular use, which is called its *function*; thus the heart circulates the blood.

OS'SE OUS (-us). Bone-like.

OS'SI FY (*ossa*, bones; *facio*, I make).

OX I DA'TION. The process of combining with oxygen.

OX'Y GEN. The active element of the air.

PAL'ATE (*palatum*, the palate). Roof of the mouth.

PAN'CRE AS (*pas*, all; *kreas*, flesh). An organ of digestion.

PA PIL'LA, plu. papillæ. Tiny cone-like projections.

PA RAL'Y SIS. A disease in which one loses sensation, or the power of motion, or both.

PA ROT'ID (*para*, near; *ous*, *otos*, ear). One of the salivary glands.

PA TEL'LA (a little dish). The knee-pan.

PEC'TO RAL. Pertaining to the chest.

PEP'SIN (*pepto*, I digest). The chief constituent of the gastric juice.

PER'I CAR'DI UM (*peri*, around; *kardia*, the heart). The membrane wrapping the heart.

PER'I OS'TE UM (*peri*, around; *osteon*, bone). The membrane around the bone.

PER'I STAL'TIC (*peri*, round; *stallein*, to arrange). Applied to the worm-like movement of the alimentary canal.

PHAR'YNX (făr'inx). From *pharugx*, the throat.

PI'A MA'TER (tender mother). See Brain.

PIG'MENT. A paint.

PLAS'MA (plaz'-mah). The nutritious fluid of the blood.

PLEU'RA (plū'-rah). From *pleura*, a rib. The membrane that lines the chest and wraps the lungs.

PRES BY O'PI A (*presbus*, old; *ops*, the eye). A defect in the eye common to old age.

PROC'ESS. A projection. Sometimes it retains its ordinary meaning of "operation."

PY LO'RUS (a gate). The doorway through which the food passes from the stomach.

PUL'MO NA RY (*pulmo*, the lungs). Pertaining to the lungs.

RA'DI US. A Latin word meaning the spoke of a wheel, a ray, etc.

RAM'I FY. To spread like the branches of a tree.

RES'PI RA'TION (*re*, again; *spiro*, I breathe). Act of breathing.

RET'I NA (*rete*, a net). The expansion of the optic nerve in the eye.

SA'CRUM (sacred). So named, it is said, because this bone of the pelvis was anciently offered in sacrifice.

SA LI'VA. A Latin word meaning spittle; the fluid secreted by the salivary glands.

SCAP'U LA. The shoulder-blade.

SCAV'EN GER. A street-sweeper.

SCLE ROT'IC (skle-rot'ic). The outer coat of the eye.

SE CRE'TION (*secretum*, to separate).

SED'EN TA RY persons are those who sit much.

SEN'SO RY NERVES. The nerves of feeling.

SE'ROUS MEMBRANE. A thin tissue, or skin, covering the cavities of the body that are not open to the external air.

SE'RUM. The thin part of the blood.

SUB CLA'VI AN. Located under the clavicle.

SUB LIN'GUAL (*sub*, under; *lingua*, the tongue). The salivary gland located under the tongue.

SUB MAX'IL LA RY (*sub*, under; *maxilla*, jaw-bone). The salivary gland located under the jaw.

SYN O' VI A (*sun*, with; *oon*, egg). A fluid that lubricates the joints.

SYN O'VI AL MEMBRANE packs the joints.

SYS'TO LE (*sustello*, I contract). Contraction of the heart.

TEM'PO RAL. An artery on the temple (*tempus*, time), so-called because, as is said, the hair whitens first at that point.

TEN'DONS (*tendo*, I stretch). The cords conveying motion from the muscle to the bone.

THO'RAX (a breast-plate). The cavity containing the lungs, etc.

TIB'I A. The shin-bone.

TIS'SUE. A general term applied to the textures of which the different organs are composed ; osseous tissue forms bones.

TRA'CHE A (trā'-kē-ă). Means rough, alluding to the roughened surface of the windpipe.

TRI'CEPS. A muscle with three heads, or origins.

TRI CUS'PID (*tres*, three ; *cuspis*, point). A valve of the heart.

TYM'PA NUM (a drum) of the ear.

VAS'CU LAR (*vasculum*, little vessel). Full of small blood-vessels

VEN'TRI CLE (-kl). A cavity of the heart.

VER'TE BRA, plu. vertebræ (*verto*, I turn). A term applied to each onc of the bones of the spine.

VIL'LUS (*villus*, tuft of hair), plu. villi.

VIT'I ATE. To taint. To spoil.

VIT'RE OUS (*vitrum*, glass). Glassy.

VO'MER (plowshare). A bone of the nose.

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